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Facultat de
Psicologia i Logopèdia

EXPLORING NEW READING HABITS AND THEIR RELATIONSHIP WITH READING COMPREHENSION

Doctoral dissertation with international doctorate mention



Presented by

LIDIA ALTAMURA GARCÍA

Supervised by

LADISLAO SALMERÓN GONZÁLEZ, PhD, and
CRISTINA VARGAS PECINO, PhD

Valencia, September 2025



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FACULTY OF PSYCHOLOGY AND SPEECH THERAPY

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*A ti, papá,
porque no hay día en el que no piense en ti.
Te echo de menos.*

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Preface

"If men learn *this*, it will implant forgetfulness in their souls; they will cease to exercise memory because they rely on that which is written, calling things to remembrance no longer from within themselves, but by means of external marks."

(Plato, trans. Jowett, 1871, *Phaedrus*, 274c–275b)

"Every new medium of communication has in its time aroused anxiety, the cinema, radio, and at one time (a chastening thought) even reading." These are the opening lines of a book entitled *Television and the child* by Himmelweit and colleagues from 1958. The text continued: "Now it is the turn of television". In this book, the authors examined the cognitive, affective and behavioural influences that television had in children's development. Such concerns, as the authors expressed, have emerged with every major innovation in human history. Even the book itself was once a revolutionary invention that provoked alarm among philosophers during the fifth century BCE. Socrates, as recorded by his disciple Plato, feared that the shift to reading and writing would weaken memory and alter the nature of human knowledge.

Nearly seventy years later, we find ourselves confronting similar anxieties, this time, about the effects of digital reading devices. In this doctoral dissertation, we will address concerns that have been raised by parents and teachers regarding the influence of digital reading on reading comprehension development, accompanied by decreasing global trends in reading

comprehension and reading motivation levels. While previous studies have examined how reading comprehension varies across media (print vs. digital), in this dissertation we adopt a distal stance, studying how a recurrent reading practice (reading habits) in digital format can influence reading comprehension development over time. To achieve this, we will present three studies that: (1) analyze the existing literature on the relationship between digital reading habits and reading comprehension; (2) develop a reliable instrument capable of measuring the multidimensional nature of reading habits of primary school students; and (3) investigate the influence of digital reading habits on reading comprehension and motivation development using a three-year longitudinal design.

Summary

The present dissertation has explored new reading habits and their relationship with reading comprehension, with a particular interest on digital reading habits. It consists of five chapters in which we first contextualize the topic through a theoretical introduction; next, we present three empirical studies; and lastly, we provide an overarching discussion. In Chapter 1 (Theoretical Introduction) we review how the definition of reading comprehension has evolved, incorporating and connecting factors such as text, reader and context. We describe how the technological progress over time has also introduced changes in the available reading content and media, shaping readers' habits. From international large-scale assessments data, we highlight current declining trends for print reading habits whilst increasing for those in digital devices. These trends, coupled with diminishing levels in global reading comprehension and reading motivation, set the need to explore the dynamics between these variables. In relation to this need, the present dissertation pursued two primary objectives. First, it aimed to investigate the relationship between digital reading habits and reading comprehension from existing literature. Second, it sought to explore the longitudinal associations among digital reading habits, reading comprehension, and reading motivation in Spanish primary school students. These two aims were designed to be complementary, in order to provide a more comprehensive understanding of the interrelations between digital reading habits and reading comprehension.

In Chapter 2 we present Study 1, a meta-analysis that examined the relationship between digital reading habits and reading comprehension from a set of 26 studies (40 effect sizes) published between 2000 and 2022. The average effect size reflected a small significant effect on reading comprehension, which contrasts with the medium size effects found in the literature related to print reading habits and comprehension. This relationship was significantly

moderated by the reader's educational stage. At early stages (primary and middle school) negative relationships were observed between leisure digital reading and text comprehension, while at later stages (high school and university) the relationship turned positive. The small negative association found for young students set the need to continue exploring digital reading habits in more depth. To this end, we carried out two studies focusing on Spanish primary school students from grade 4 to 6. In Chapter 3, we describe Study 2, which was motivated by the considerable heterogeneity observed in the measurement of digital reading habits in Study 1. In Study 2, we developed an instrument to be able to capture children's reading habits differentiating between reading media (print and digital) and reading purpose (leisure and academic). This instrument received the name Multidimensional Reading Habits Instrument (MRHI) and consists of two questionnaires, categorized by reading purpose, in which students indicate their reading frequency of different reading activities. Each questionnaire contains eight items, evenly divided between print-based and digital activities. Through different sources of validity evidence, the MRHI exhibited good validity evidence regarding internal structure and test-criterion relationships with reading comprehension and reading motivation. These test-criterion relationships were consistent with prior literature and aligned with the findings from Study 1. Specifically, digital reading habits showed negative correlations with both reading comprehension and intrinsic motivation, whereas print reading habits were positively associated with both. Additionally, in Study 2, we also confirmed that students read more frequently for academic purposes, particularly in print. The second most frequent activity was leisure reading in digital format, followed by academic digital reading. Lastly, leisure reading in print was reported with the lowest frequency. After having validated this instrument, we employed it in a longitudinal study (Study 3) presented in Chapter 4. In Study 3, we directly addressed the second research objective of this dissertation. We examined the dynamic relationships between digital reading habits (leisure and academic), reading comprehension

and intrinsic reading motivation over time. We followed students from grade 4 to 6 of primary school in the region of Valencia, Spain, who were assessed annually, measuring their reading habits frequency, their reading comprehension and reading motivation levels. Results revealed null causal paths between digital reading habits and reading comprehension for both leisure and academic purposes. Initial longitudinal analyses revealed that reading comprehension and intrinsic reading motivation presented positive reciprocal cross-paths. These analyses also revealed negative paths from digital reading habits towards intrinsic reading motivation. After accounting for stable individual differences, we determined that reading comprehension and intrinsic reading motivation more likely presented a stable-trait relationship, rather than dynamic, time-specific influences. Regarding reading habits, only one significant path remained as significant: from academic digital reading habits in grade 5 to decreased intrinsic reading motivation in grade 6.

In Chapter 5 we provide an integrative summary of the key findings, highlighting the overall null relationship between digital reading habits and reading comprehension. We continue describing educational and methodological implications of our results. Lastly, we suggest future research lines that could expand and complete the present findings.

Resumen

La presente tesis ha explorado los nuevos hábitos de lectura y su relación con la comprensión lectora, con un interés particular en los hábitos de lectura en formato digital. Consta de cinco capítulos en los que, en primer lugar, contextualizamos el tema a través de una introducción teórica; a continuación, presentamos tres estudios empíricos; y, por último, ofrecemos una discusión general. En el Capítulo 1 (Introducción Teórica) se revisa cómo ha evolucionado la definición de comprensión lectora, incorporando y conectando factores como el texto, el lector y el contexto. Se describe cómo el avance tecnológico ha introducido también cambios en los contenidos y medios de lectura disponibles, configurando así los hábitos de los lectores. A partir de datos de evaluaciones internacionales a gran escala, se destacan las tendencias actuales de disminución en los hábitos de lectura en papel y el aumento de aquellos realizados en dispositivos digitales. Estas tendencias, junto con los niveles decrecientes de comprensión lectora y motivación lectora a nivel mundial, justifican la necesidad de explorar la dinámica entre estas variables. En relación con esta necesidad, la presente tesis persiguió dos objetivos principales. En primer lugar, se propuso investigar la relación entre los hábitos de lectura digital y la comprensión lectora a partir de la literatura existente. En segundo lugar, se buscó explorar las asociaciones longitudinales entre los hábitos de lectura digital, la comprensión lectora y la motivación lectora en estudiantes de Educación Primaria en España. Estos dos objetivos fueron planteados de forma complementaria, con el fin de ofrecer una comprensión más completa de las interrelaciones entre los hábitos de lectura digital y la comprensión lectora.

En el Capítulo 2 se presenta el Estudio 1, un metaanálisis que examinó la relación entre los hábitos de lectura digital y la comprensión lectora a partir de un conjunto de 26 estudios (40 tamaños del efecto) publicados entre los años 2000 y 2022. El tamaño del efecto promedio reflejó un efecto pequeño pero significativo sobre la comprensión lectora, en contraste con los

efectos de tamaño medio encontrados en la literatura sobre hábitos de lectura en papel y comprensión. Esta relación estuvo moderada significativamente por la etapa educativa del lector. En las etapas iniciales (educación Primaria y Secundaria) se observaron relaciones negativas entre la lectura digital por ocio y la comprensión de textos, mientras que en etapas más avanzadas (Bachillerato y Universidad) la relación pasó a ser positiva. La pequeña asociación negativa encontrada en estudiantes más jóvenes puso de manifiesto la necesidad de seguir explorando en profundidad los hábitos de lectura digital. Con este fin, se llevaron a cabo dos estudios centrados en alumnado de cuarto a sexto de Educación Primaria en España.

En el Capítulo 3 se describe el Estudio 2, motivado por la considerable heterogeneidad observada en la medición de los hábitos de lectura digital en el Estudio 1. En este estudio se desarrolló un instrumento capaz de captar los hábitos de lectura del alumnado diferenciando entre el soporte de lectura (papel o digital) y la finalidad de la lectura (ocio o académica). Este instrumento recibió el nombre de Multidimensional Reading Habits Instrument (MRHI) [Instrumento Multidimensional de Hábitos de Lectura] y consta de dos cuestionarios, categorizados según la finalidad de la lectura, en los que el alumnado indica su frecuencia de lectura en diferentes actividades lectoras. Cada cuestionario contiene ocho ítems, divididos equitativamente entre actividades en papel y en formato digital. A través de diferentes fuentes de evidencia de validez, el MRHI mostró buenas evidencias de validez tanto en la estructura interna como en las relaciones test-criterio con la comprensión lectora y la motivación lectora. Estas relaciones test-criterio fueron coherentes con la literatura previa y se alinearon con los hallazgos del Estudio 1. Concretamente, los hábitos de lectura digital mostraron correlaciones negativas tanto con la comprensión lectora como con la motivación intrínseca, mientras que los hábitos de lectura en papel se asociaron positivamente con ambas. Además, en el Estudio 2 también se confirmó que los estudiantes leen con mayor frecuencia con fines académicos, especialmente en papel. La segunda actividad más frecuente fue la lectura digital por ocio,

seguida por la lectura académica digital. Por último, la lectura por ocio en papel fue la menos frecuente.

Una vez validado este instrumento, lo utilizamos en un estudio longitudinal (Estudio 3), presentado en el Capítulo 4. En este estudio abordamos directamente el segundo objetivo de investigación de esta tesis. Examinamos las relaciones dinámicas entre los hábitos de lectura digital (por ocio y académica), la comprensión lectora y la motivación intrínseca por la lectura a lo largo del tiempo. Se hizo seguimiento al alumnado de cuarto a sexto de Primaria en la provincia de Valencia, evaluándoles anualmente en cuanto a su frecuencia de hábitos lectores comprensión lectora y niveles de motivación lectora. Los resultados revelaron efectos causales nulos entre los hábitos de lectura digital y la comprensión lectora, tanto en lectura por ocio como académica. Los análisis longitudinales iniciales mostraron efectos positivos y recíprocos entre la comprensión lectora y la motivación intrínseca. También se observaron efectos negativos desde los hábitos de lectura digital hacia la motivación intrínseca del siguiente año. Una vez controladas las diferencias individuales estables, se determinó que la comprensión lectora y la motivación intrínseca presentaban una relación estable de rasgo, en lugar de influencias dinámicas específicas en el tiempo. En cuanto a los hábitos de lectura, solo un efecto temporal se mantuvo significativo: desde los hábitos de lectura académica en formato digital en quinto de Primaria hacia una disminución de la motivación intrínseca en sexto grado.

En el Capítulo 5 se ofrece un resumen que integra los principales hallazgos, destacando la ausencia general de relación entre los hábitos de lectura digital y la comprensión lectora. A continuación, se describen las implicaciones educativas y metodológicas de los resultados. Finalmente, se proponen líneas futuras de investigación que podrían ampliar y completar los hallazgos aquí presentados.

Resum

La present tesi ha explorat els nous hàbits de lectura i la seua relació amb la comprensió lectora, amb un interès particular pels hàbits de lectura en format digital. Consta de cinc capítols en què, en primer lloc, contextualitzem el tema a través d'una introducció teòrica; a continuació, presentem tres estudis empírics; i, finalment, oferim una discussió general. Al Capítol 1 (Introducció Teòrica) es revisa com ha evolucionat la definició de comprensió lectora, incorporant i connectant factors com el text, el lector i el context. Es descriu com l'avenç tecnològic també ha introduït canvis en els continguts i suports de lectura disponibles, configurant així els hàbits lectors. A partir de dades d'avaluacions internacionals a gran escala, es destaquen les tendències actuals de disminució dels hàbits de lectura en paper i l'increment d'aquells realitzats en dispositius digitals. Aquestes tendències, junt amb els nivells decreixents de comprensió lectora i motivació lectora a escala mundial, justifiquen la necessitat d'explorar la dinàmica entre aquestes variables. En relació amb aquesta necessitat, la present tesi va perseguir dos objectius principals. En primer lloc, es va proposar investigar la relació entre els hàbits de lectura digital i la comprensió lectora a partir de la literatura existent. En segon lloc, es va cercar explorar les associacions longitudinals entre els hàbits de lectura digital, la comprensió lectora i la motivació lectora en alumnat d'Educació Primària a Espanya. Aquests dos objectius es van plantejar de manera complementària, amb la finalitat d'oferir una comprensió més completa de les interrelacions entre els hàbits de lectura digital i la comprensió lectora.

Al Capítol 2 es presenta l'Estudi 1, un metaanàlisi que va examinar la relació entre els hàbits de lectura digital i la comprensió lectora a partir d'un conjunt de 26 estudis (40 grandàries de l'efecte) publicats entre els anys 2000 i 2022. La grandària de l'efecte mitjana va reflectir un efecte menut però significatiu sobre la comprensió lectora, en contrast amb els efectes de grandària mitjana trobats en la literatura sobre hàbits de lectura en paper i

comprensió. Aquesta relació va estar moderada de manera significativa per l'etapa educativa del lector. En les etapes inicials (Educació Primària i Secundària) es van observar relacions negatives entre la lectura digital per oci i la comprensió de textos, mentre que en etapes més avançades (Batxillerat i Universitat) la relació esdevenia positiva. La xicoteta associació negativa trobada en estudiants més joves va posar de manifest la necessitat de continuar explorant en profunditat els hàbits de lectura digital. Amb aquesta finalitat, es van dur a terme dos estudis centrats en alumnat de quart a sisé de Primària a Espanya.

Al Capítol 3 es descriu l'Estudi 2, motivat per la considerable heterogeneïtat observada en la mesura dels hàbits de lectura digital en l'Estudi 1. En aquest estudi es va desenvolupar un instrument capaç de captar els hàbits lectors de l'alumnat diferenciant entre el medi de lectura (paper o digital) i propòsit de la lectura (oci o acadèmic). Aquest instrument va rebre el nom de Multidimensional Reading Habits Instrument (MRHI) [Instrument Multidimensional d'Hàbits de Lectura] i consta de dos qüestionaris, categoritzats segons el propòsit de la lectura, en els quals l'alumnat indica la freqüència amb què realitza diverses activitats lectores. Cada qüestionari conté huit ítems, dividits equitativament entre activitats en paper i en format digital. A través de diferents fonts d'evidència de validesa, el MRHI va mostrar bones evidències de validesa tant en l'estructura interna com en les relacions test-criteri amb la comprensió lectora i la motivació lectora. Aquestes relacions van ser coherents amb la literatura prèvia i s'alinearen amb les troballes de l'Estudi 1. Concretament, els hàbits de lectura digital mostraren correlacions negatives tant amb la comprensió lectora com amb la motivació intrínseca, mentre que els hàbits de lectura en paper s'associaren positivament amb ambdues. A més, en l'Estudi 2 també es va confirmar que els estudiants llegeixen amb més freqüència amb finalitats acadèmiques, especialment en paper. L'activitat més freqüent després d'aquesta fou la lectura digital per oci, seguida de la lectura acadèmica digital. Finalment, la lectura per oci en paper fou l'activitat menys freqüent.

Una vegada validat aquest instrument, el vam utilitzar en un estudi longitudinal (Estudi 3), presentat al Capítol 4. En aquest estudi abordàrem directament el segon objectiu de recerca d'aquesta tesi. Vam examinar les relacions dinàmiques entre els hàbits de lectura digital (per oci i acadèmics), la comprensió lectora i la motivació intrínseca per la lectura al llarg del temps. Es va fer seguiment a l'alumnat de quart a sisé de Primària a la província de València, a qui s'avaluà anualment quant a la freqüència dels seus hàbits lectors, la comprensió lectora i els nivells de motivació lectora. Els resultats van revelar efectes causals nuls entre els hàbits de lectura digital i la comprensió lectora, tant en lectura per oci com en lectura acadèmica. Les anàlisis longitudinals inicials van mostrar efectes positius i recíprocs entre la comprensió lectora i la motivació intrínseca. També es van observar efectes negatius des dels hàbits de lectura digital cap a la motivació intrínseca l'any següent. Una vegada controlades les diferències individuals estables, es va determinar que la comprensió lectora i la motivació intrínseca presentaven una relació estable de tret, en lloc d'influències dinàmiques específiques del moment. Pel que fa als hàbits de lectura, només un efecte temporal es va mantindre significatiu: el que anava dels hàbits de lectura acadèmica en format digital en cinqué de Primària cap a una disminució de la motivació intrínseca en sisé.

Al Capítol 5 s'ofereix un resum que integra els principals resultats, destacant l'absència general de relació entre els hàbits de lectura digital i la comprensió lectora. A continuació, es descriuen les implicacions educatives i metodològiques dels resultats. Finalment, es proposen línies futures d'investigació que podrien ampliar i completar les troballes ací presentades.

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Chapter I



Theoretical Introduction

Chapter I

Theoretical Introduction

Comprehending texts is a fundamental skill for all students worldwide, serving as the foundation for academic success and lifelong learning (Alexander, 2005; Kendeou et al., 2007; Oakhill et al., 2014; OECD, 2019). In an increasingly information-driven society, most knowledge is transmitted through written language, especially in formal academic settings, whether in textbooks, digital articles or multimedia presentations. In this theoretical introduction, we will first examine how reading comprehension has been conceptualized in the scientific literature, and how those conceptions have influenced the way reading comprehension is assessed. Secondly, we will review how digitalization of reading has shaped new reading habits and the implications for digital reading comprehension conceptualization. Lastly, we will describe how this digitalization can influence reading comprehension development and which individual factors can be relevant in this process, particularly, reading motivation.

1.1. Evolution in reading comprehension conceptualization and assessment

To describe how the conceptualizations of reading comprehension have evolved in the scientific literature, we will focus on three key elements of this construct (Pearson & Cervetti, 2015; Snow, 2002): text, reader, and context. Throughout the history of the field, each of these elements has played a central role in shaping our understanding of reading comprehension (Pearson & Cervetti, 2015), leading to three conceptual overarching trends: the text-centric, the reader-centric, and the context-centric trends.

1.1.1. The text-centric trend

The earliest theories of reading comprehension date back to the late 19th and early 20th

centuries, when researchers began exploring how readers construct meaning from text. Shaped by behaviorism (Skinner, 1957; Thorndike, 1910; Watson, 1913), internal cognitive processes were first considered unobservable, and reading was explained through stimulus-response mechanisms, where text features directly influenced comprehension. This perspective gave rise to bottom-up models of reading comprehension, which posited that meaning resided in the text itself, and comprehension resulted from a linear, step-by-step decoding process. Comprehension was seen as a product of this perceptual and linguistic decoding process. This perspective was the inspiration for the *Simple View of Reading* (SVR, Gough & Hillinger, 1980; Hoover & Gough, 1990) which conceives reading comprehension as the product of word decoding (the ability to recognize words) and listening comprehension (the ability to understand spoken language).

According to the SVR, reading comprehension is understood as a combination of discrete sub-skills that can be taught, measured, and mastered independently. Thus, to enhance reading comprehension, emphasis is placed on developing each component. The SVR is one of the foundational and most influential theoretical models to understand reading comprehension, and it is particularly popular when studying early language and reading comprehension development, like in elementary school children (Hjetland et al., 2017). From this text-centric view researchers and educators focus on each component. On the one hand, to examine and improve word decoding instructors the focus is on phonological awareness, letter knowledge and rapid automatized naming (RAN). On the other hand, to examine and work on listening comprehension, the focus is on receptive and expressive vocabulary, grammatical and narrative skills (see Hjetland et al., 2017 for a review).

1.1.2. The reader-centric trend

The cognitive revolution of the late 1960s and 1970s (Bruner, 1960) shifted the focus of reading comprehension from the text to the reader, giving place to new, complementary views of

reading comprehension. Psychologists moved beyond behaviorism, exploring the internal cognitive processes involved in comprehension, memory, and knowledge acquisition. Reading conceptualization was influenced by the *information-processing theory* (Shiffrin & Atkinson, 1969), placing the focus on how the reader receives, processes, stores, and retrieves information, often comparing cognition to a computer system. By the late 1970s and 1980s, the *reader-response theory*, proposed by Rosenblatt (1938, 1976), gained prominence, emphasizing that meaning arises from the interaction between the reader and the text. This theory supports the idea that individual experiences and interpretations shape understanding.

Later on, the emergence of *schema theory* (Anderson & Pearson, 1984; Rumelhart, 1978) highlighted the role of prior knowledge in comprehension. The emphasis was on how reading comprehension varied depending on the reader's characteristics. Specifically, the reader-trend focused on how prior knowledge, stored in memory, could influence the comprehension of new information. Another characteristic of this trend is that the theoretical models explained reading comprehension as a series of sequential processing stages (Kintsch & van Dijk, 1978). The new focus on the reader led to one of the most influential theoretical models in reading comprehension research: the *construction-integration (CI) model* (Kintsch, 1988). In this model, reading comprehension is described as a two-phase cognitive process: construction followed by integration. During the construction phase, the reader processes the text in a bottom-up manner, decoding the surface structure of words and syntax to generate a broad range of meanings and ideas. Particularly, Kintsch refers to “propositions” which are defined as the basic unit of meaning in a text. The construction phase includes activating multiple possible interpretations, even those that may be irrelevant or contradictory. This is because the activation happens in a rather automatic and passive way. The integration phase then follows, functioning as a top-down process in which the reader evaluates and refines these activated meanings. In this phase, irrelevant or incoherent ideas are suppressed, while

contextually appropriate propositions are strengthened and connected, ideally, resulting in a coherent understanding of the information. These two phases, construction and integration, underlie the formation of three levels of meaning construction in reading comprehension (Kintsch, 1988): surface level, textbase level and situation model. 1) The *surface or linguistic level* represents the processing of the words that are read in the text. It involves decoding, recognizing and parsing words. 2) The *textbase* level represents the formation of ideas based on textual information, also referred to as propositions. The textbase level represents a sufficient but superficial understanding of the texts' ideas. Building on the textbase level, 3) the *situation model* represents the highest level of understanding because it involves inferences that go beyond the textual meaning, including integration not only from the different parts of the text but also from the reader's prior knowledge. Orthogonal to these three levels of mental representation is the differentiation between *microstructure* and *macrostructure* of each level. The microstructure encompasses the local, sentence-level content of the text, as integrated with relevant background knowledge. In contrast, the macrostructure (van Dijk, 1980) refers to a hierarchically organized set of propositions that capture the global meaning or thematic structure of the text. While sometimes explicitly indicated, the macrostructure often must be inferred by the reader. An ideal summary corresponds to this macrostructure and can vary in generality, reflecting different hierarchical levels (e.g., major themes vs. subthemes).

Kintsch CI model has served as a foundation for subsequent models that have also focused on the processes needed to achieve meaning construction. In 1999, van den Broek and colleagues expanded the CI presenting the landscape model. Focusing on the dynamic interaction between textual information and the reader's prior knowledge and goals, the *Landscape Model* builds upon constructionist theory (e.g., Graesser et al., 1994). The model emphasizes that comprehension is not solely a passive decoding of text, but rather an active, goal-directed process shaped by the reader's purposes and cognitive state. Central to the model

is the concept of *standards of coherence*, which are internal criteria readers use to evaluate whether their understanding of the text meets their comprehension goals. According to the model, when readers detect inconsistencies, gaps in understanding, or a failure to meet these standards, they may adjust their reading strategies, such as re-reading, making inferences, or consulting prior knowledge, to restore coherence. Importantly, these standards of coherence are not fixed but are modulated by several variables, including motivation, cognitive fatigue, reading instructions, and task demands. For instance, a reader highly motivated to understand complex material may impose stricter coherence standards than a fatigued reader engaged in a casual reading task. This flexibility underscores the model's recognition of individual differences and situational influences in reading. By incorporating this metacognitive regulation, the landscape model positions comprehension as a fluid, adaptive process wherein readers actively construct and revise mental representations in response to both internal and external constraints (van den Broek et al., 1999; van den Broek & Helder, 2017).

The cognitive revolution also brought a transformation in reading comprehension assessment by the mid-1980s. Educational practices shifted from a focus on isolated skills to the use of strategies designed to enhance the cognitive processes underlying reading. As a result, assessments evolved, encouraging students to engage with texts by integrating new information with their prior knowledge (Pearson & Cervetti, 2015). Classroom-based assessment methods like think-alouds and portfolios gained popularity (Sabatini et al., 2019; Sarroub & Pearson, 1998). Think-alouds, where students verbalize their thought processes while reading, became a valuable tool for understanding how students approached reading tasks and how they constructed meaning. This method has allowed to assess not just the final product of comprehension, such as answers to questions, but also the underlying processes that lead to that understanding (e.g., establishment of inferences, integration with previous knowledge, comprehension monitoring...) (Wade, 1990). Portfolios, which involve students compiling a

collection of their work over time, have provided a more holistic view of a student's reading development (Bird, 1990). Portfolios could include a variety of assessments, such as written reflections, annotations, and self-assessments, offering insight into how a student was engaging with and self-regulating the reading process. These types of assessments are more common once the reader has acquired some foundational reading basis and is able to go beyond basic reading comprehension tasks (such as the ones described under the SVR). Therefore, this type of assessment is adequate from primary school years (Doğan et al., 2024).

1.1.3. The context-centric trend

Alongside the cognitive revolution and constructionist influences, other researchers began to question the applicability of the laboratory results in real life and supported a sociocultural approach that emphasized the context of the reader as a major player in reading comprehension. Vygotsky's (1978) *sociocultural theory* supported that learning (including reading comprehension) occurs through social interactions and scaffolding provided by a mentor with a higher degree of knowledge that could guide the learner (i.e., parents, teachers, knowledgeable peers...). Building on these ideas, Bronfenbrenner criticized the methods used in psychological research, as he stated that much of developmental psychology was the "science of the strange behavior of children in strange situations with strange adults for the briefest possible periods of time" (Bronfenbrenner, 1979, p. 19). Fighting against the neglect of contextual influences and poor authentic research methodologies, he developed the *ecological systems theory* (Bronfenbrenner, 1979), proposing a broader framework for understanding human development. This view emphasized that cognitive processes occur within nested social contexts that interact between them and influence literacy development. Bronfenbrenner originally described four nested systems that interacted with each other, ultimately influencing the development of the child: microsystem, mesosystem, exosystem and

macrosystem: 1) The microsystem includes immediate environments like home, school, peer groups, and community spaces that directly influence a child's development. 2) The mesosystem involves interactions between these environments, such as parent-teacher communication enhancing learning consistency. 3) The exosystem consists of external factors that indirectly impact the child, like a parent's workplace or school board. 4) Lastly, the macrosystem encompasses broader cultural and societal influences, including language, social norms, and systemic inequalities.

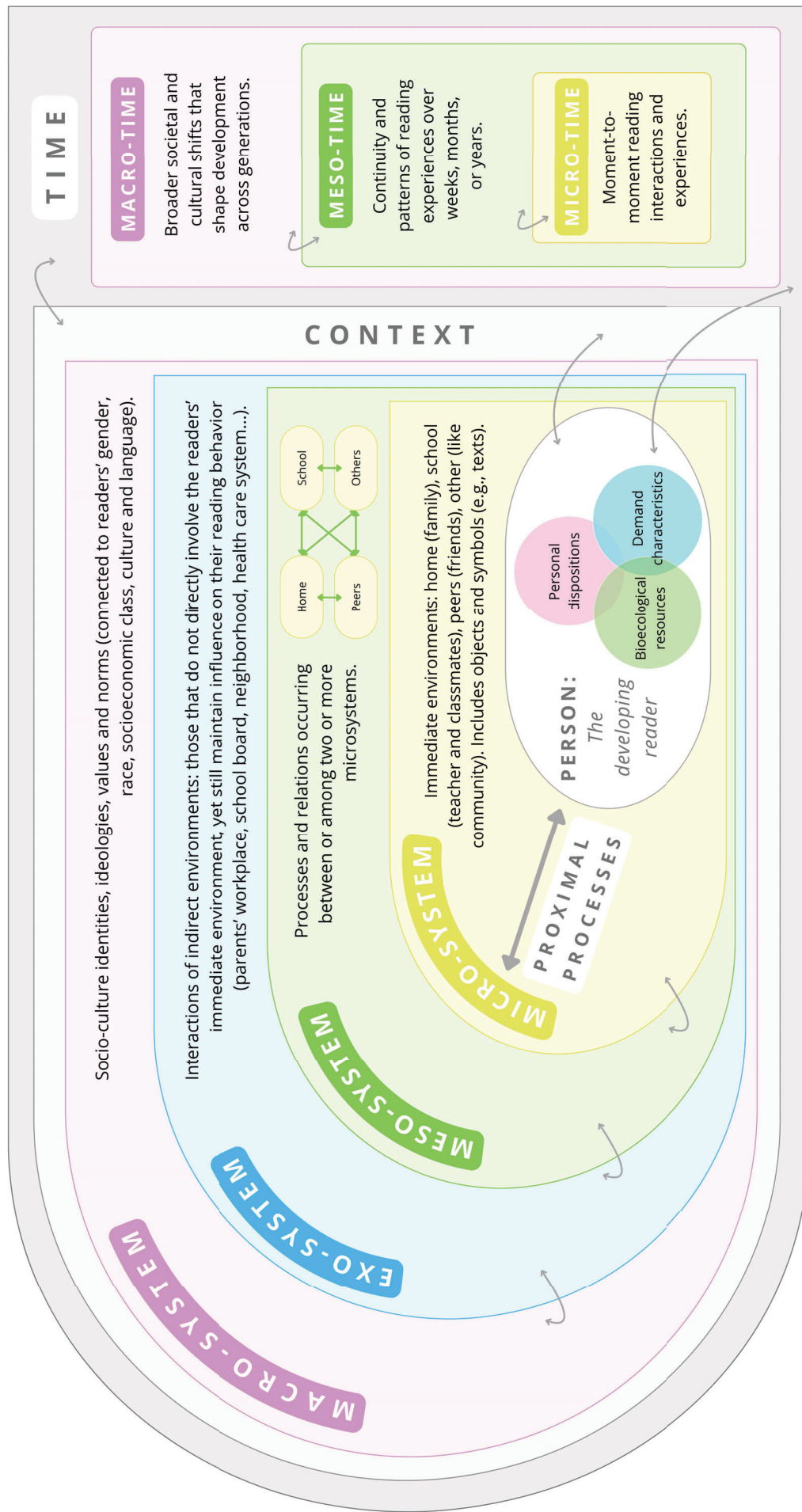
After some revisions, in 1986, Bronfenbrenner introduced the term “chronosystem”. This layer accounts for the dimension of time and its influence on a child's development, recognizing that environmental changes and life transitions occur across different stages of life. In 1998, and later refined in 2007, Bronfenbrenner and Morris presented a reconceptualization of the ecological systems proposing the PPCT model. The name makes reference to its four components: Processes, Person, Context and Time. With this model, the authors recognized that the active role of the child as an agent in their development had been neglected in their previous versions, retrieving some influence from the reader-centric trend. In the PPCT the child regained agency and their individual characteristics were taken into consideration under the *Person* component. Because this model was conceived to explain “human development” in a broad sense, we can interpret the components and adapt the model to a specific life dimension. In our case we will refer to “reading development” and the Person will be considered the “developing reader”. This first component includes personal dispositions (e.g., having a high reading motivation), bioecological resources (e.g., cognitive abilities, prior knowledge) and demand characteristics (e.g., observable traits or qualities that influence how others interact with the reader). The *Context* component refers to the environments that influence directly and indirectly on the reader development (i.e., micro-, meso-, exo- and macro-systems). The *Process* component particularly refers to the reciprocal interaction between an active evolving

reader and their immediate environment (i.e., the micro-system) in determined Time periods. Such processes receive the name of proximal processes and are considered the component that mainly drives development. In the PPCT the micro-system includes not only other humans such as parents, teachers and peers, it also involves objects and symbols. When referring to reading comprehension development, we can consider the Text as part of these objects (e.g., any written material) and symbols (e.g., graphical representations such as words that conform language), following Jaeger (2016) interpretation. Lastly, the *Time* component, previously known as the chronosystem, is now described with more nuanced terms in the PPCT model. It includes three distinct categorizations of time: micro-, meso-, and macro-time. 1) Microtime refers to moment-to-moment interactions that shape a child's development, such as re-reading a sentence for better understanding. 2) Mesotime involves patterns of experiences over time, like daily bedtime reading improving comprehension, or disruptions from events like pandemics or natural disasters affecting the micro-time dynamics. 3) Macrotime encompasses broader societal changes, such as shifts in educational policies and technology advancements, which influence learning over generations. The adapted interpretation of the PCCT model to reading development is graphically presented in Figure 1.1, inspired by the theoretical adaptation of Jaeger (2016).

The influence of the context-centric trend in reading comprehension assessment can be seen in emerging approaches that emphasize the role of teachers and experts in the reading process, as well as the need for more authentic reading scenarios. Valencia and Pearson (1987) argued that “a scenario in which there is no difference between reading, instruction, and assessment is the ideal” (p. 4). They advocated for assessing reading comprehension through observation techniques, where teachers provided scaffolding to support students' understanding while reading texts for a genuine purpose. This approach was known as

Figure 1.1

Graphical representation of the PCCT model applied to reading development



Note. Adaptation of the ecological systems theory (Bronfenbrenner, 1979, 1986) and the Process-Person-Context-Time (PPCT) model (Bronfenbrenner & Morris, 1998, 2007) to reading comprehension development (Jaeger, 2016).

“dynamic assessment” (Campione & Brown, 1985), drawing directly from Vygotsky’s concept of the zone of proximal development (Vygotsky, 1978). Rather than relying on a single score that reflected the level of reading comprehension, dynamic assessment aimed to provide an index of the type and amount of support a student required to advance in their understanding. Additionally, environment influences were taken into consideration from a rather macro-influence, defending that assessments should include texts and tasks that can be linked to students’ home and community scenarios and practices (Ladson-Billings, 1995). Nowadays, we use the term “socioculturally responsive assessments” or SCRA (Bennet, 2023).

1.1.4. The balanced trend

At the beginning of the 21st century, the separate influences that emphasized one of the three elements of reading comprehension (text, reader, or context) led to the need for new theoretical frameworks that integrated and balanced all three. While the PPCT model provides a broad explanation of human development (Bronfenbrenner & Morris, 2007), one of the most influential frameworks that combines essential theoretical models tailored to reading comprehension is the *Reading for Understanding* by Snow and the RAND group (2002), from now on we will refer to this as the RAND model. This framework presents a heuristic that describes reading comprehension as a dynamic process shaped by the interaction of four key components (see Figure 1.2 for a graphical representation):

1. **The Reader** – The individual who engages with the text, bringing cognitive abilities (e.g., attention, memory, critical analytic ability, inferencing, visualization ability), motivation (a purpose for reading, topic’s interest and reader self-efficacy), and prior knowledge (about vocabulary, text’s topic, linguistic, comprehension strategies). This component builds upon the CI model, focusing on the reader’s key role in constructing meaning. The reader’s characteristics will interact with the other key components.

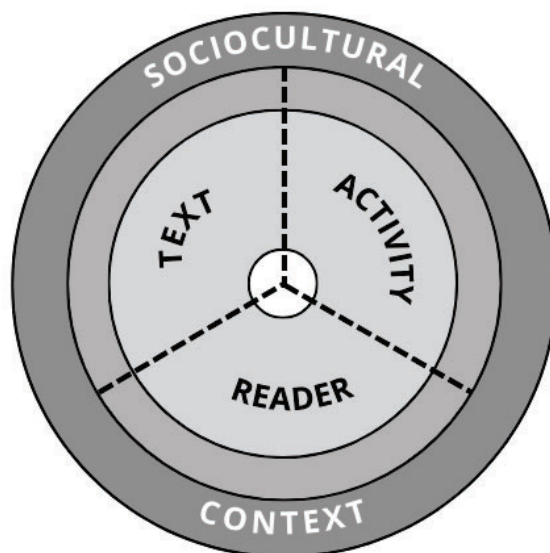
2. **The Text** – The material being read, which varies in complexity (e.g., difficult or easy), format (e.g., print vs. digital), and structure (e.g., linear vs. discontinuous). The characteristics of the text interact with the reader's features. For example, regarding complexity, if the reader has some prior knowledge about the text topic the complexity will be lower than if the reader does not count with this prior knowledge, leading to better comprehension. The reverse situation can also happen, when a reader is an expert on the topic and the structure and content of the text hinders further deep comprehension due to very basic information and unnecessary scaffolding (this is known as the expertise reversal effect). Beyond text structure or complexity, the format can also influence on the reader component. Print reading could promote more deep engagement and focus on the reader than digital ones, leading to better comprehension (this would be further explained in the next section).
3. **The Activity** – It involves one or more purposes or tasks. Inspired in the landscape model (van den Broek et al., 1999), the reader will adjust their reading process according to their reading goals. If the goal is just to answer a specific question, the reader might just skim through the text to get the answer. On the contrary, if the goal is entertainment, the level of engagement might increase, leading to more sustained attention and thorough reading. The activity will influence the reader's motivation as well, energizing the reading process if the motivation is intrinsic but diminishing if it is an external imposed task. Additionally, the outcomes of the activity might influence the reader's knowledge (e.g., learning from what is read) and can even change the initial activity purpose (e.g., from only looking for specific information to enjoying the text in its full extent). The text can also influence the activity, for example, if the text is presented in digital format, the activity can involve interactive elements or access to more instant information, than when reading in print.

4. **The Sociocultural Context** – The broader environment in which reading occurs. This component refers to the physical environments in which the reading instruction occurs, typically the school or home (close to the Context component of the PPCT, Bronfenbrenner & Morris, 1998, 2007). It also refers to non-physical influences like society norms and trends that shape reading development. For example, nowadays, technological advancements have increased access to digital devices. This historical moment demands that readers develop specific skills to succeed in reading comprehension when reading in such devices. These skills include, for example, navigating online platforms, detecting fake news, and discerning AI-generated content. Teachers can foster these abilities by proposing activities that encourage critical thinking and the comparison of different information sources. Additionally, the reader's prior knowledge and motivation will interact with both the activity that is proposed and the text's information that needs to be comprehended and acquired.

The RAND model is a good representation of the balance and interaction between text, reader and context, driven by a determined reading activity. The influences of Bronfenbrenner and Morris PCCT model are evident on the Reader (Person), Text (object of the microsystem) and Sociocultural context (Context and Time). This balanced view of reading comprehension focuses on the purposeful action of reading, emphasizing task-based approaches in more authentic reading scenarios where readers actively engage with texts to meet specific goals. This framework has influenced assessment practices at international large-scale assessment tests such as PISA (Programme for International Student Assessment) and PIRLS (Progress in International Reading Literacy Study).

Figure 1.2

Graphical representation of the RAND model (Snow, 2002)



Note. Adapted from Snow (2002).

PISA was first launched by the OECD in 2000, and it takes place every three years. PISA assesses 15-year-olds' competencies in reading, mathematics, and sciences, with each assessment cycle placing a central focus on one of these domains. Similarly, PIRLS is conducted by the International Association for the Evaluation of Educational Achievement (IEA) since 2001. This assessment is specific for measuring fourth-graders' reading competence¹, and it is administered every five years. These two large-scale assessments have relied on the RAND model, employing authentic reading scenarios. Because each assessment is tailored to different age groups, they differ in the reading tasks. On the one hand, PISA

¹ PISA defines reading literacy as “understanding, using, evaluating, reflecting on and engaging with texts in order to achieve one’s goals, to develop one’s knowledge and potential, and to participate in society” (Mo, 2019, p.2). Similarly, PIRLS defines reading literacy as “the ability to understand and use those written language forms required by society and/or valued by the individual. Readers can construct meaning from texts in a variety of forms. They read to learn, to participate in communities of readers in school and everyday life, and for enjoyment” (Mullis & Martin, 2019, p.6). These close definitions posit reading comprehension at the centre of reading literacy, so we refer to these large-scale assessments to provide international contextualization regarding reading comprehension.

presents reading scenarios designed to resemble more authentic real-life reading (e.g., reading for private use, for public use, for work or for education). PIRLS reading tasks, on the other hand, are designed to reflect the types of reading experiences typically encountered by fourth-grade students in school settings. The reading purposes are related to academic experiences: reading for literary experience or for acquiring and using information.

1.1.4.1. Students' reading comprehension trends

International assessments are particularly useful to understand current trends on reading comprehension levels worldwide. Data from PISA databases indicate a progressive decline in reading literacy scores. In Figure 1.3 we can observe a comparison of the reading literacy scores for students in Spain and the OECD countries (average) from 2000 to 2022. Overall, a general progressive decline in reading literacy scores is observed for both OECD countries and Spain.

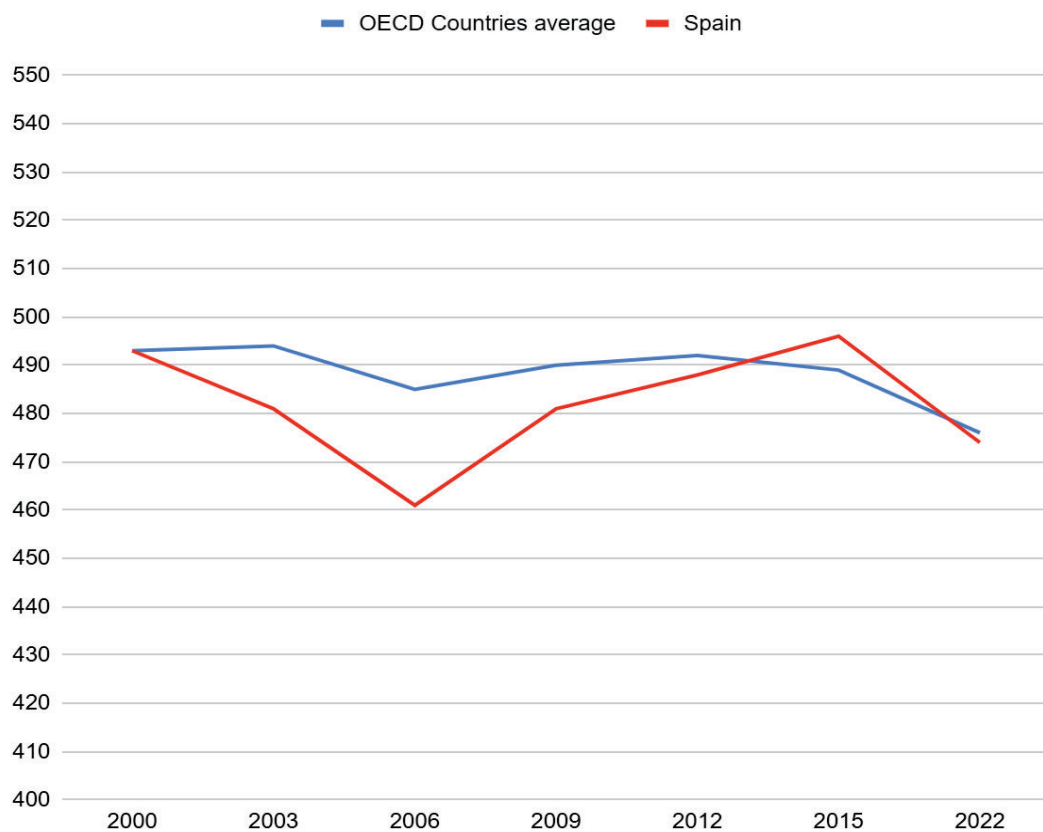
While this data belongs to secondary school students, less is known about primary school students. To know more about younger students, we next refer to PIRLS which provides information about fourth graders worldwide. In Figure 1.4 we present data from 38 countries participating countries and Spain score during the years 2006, 2011, 2016 and 2021. Overall, the results from the participating countries also indicate a declining progress on the average scores from 530 points in 2006 to 514 in 2021. In this case, Spain follows a different trajectory, with scores rising from 513 in 2006 to 528 in 2016, and experiencing a less pronounced decline by 2021, only a 7-point drop compared to the 10-point drop from 2011 to 2021 on the international average.

Of note is that this comparison is merely descriptive, we cannot support significant differences claims. As we have seen, the reading comprehension trajectories in fourth grade to secondary school are different. Even if Spanish students present relatively good reading scores in fourth grade (PIRLS data), in secondary school they show scores below OECD countries

average (PISA data). This change calls for more investigation regarding the following years of primary school, after fourth grade, in which the students are transitioning to learning to read to reading to learn (Chall, 1983; Willms, 2022). Chapter 3 and 4 will focus particularly in these last years of primary school.

Figure 1.3

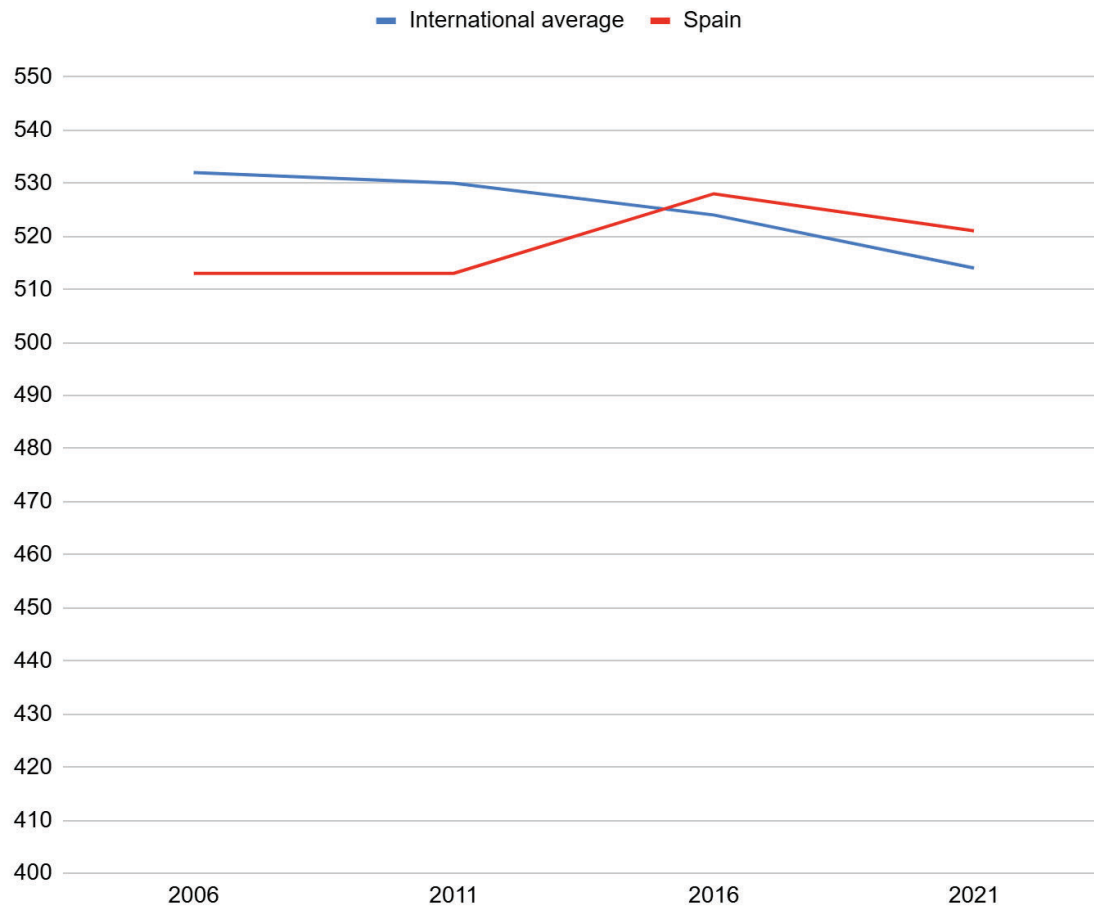
PISA reading literacy scores, Spain and OECD countries from 2000 to 2022



Note. Graph created from data available in the PISA International Data Explorer. Organization for Economic Cooperation and Development (OECD). Retrieved from <https://pisadataexplorer-pp.oecd.org/ide/idepisa>. Although Spain's PISA 2018 data meet international technical standards, its reading literacy data show unusual student response behavior and were not available, thus not presented in this graph.

Figure 1.4

PIRLS reading literacy scores, Spain and participating countries from 2006 to 2021



Note. Graph created from data in Exhibit 2.1.1: *Trend Plots of Average Reading Achievement*. Source: IEA's Progress in International Reading Literacy Study (PIRLS) (IEA, 2006, 2011, 2016, 2021), retrieved from <https://pirls2021.org/results>. Spain did not have data in 2001, therefore, it is not presented in this graph.

1.1.5. Learning to read: a life-long process

As we have seen, the evolving conceptualizations and trends of reading comprehension are complementary to each other, with different focuses and implications for assessment. Nevertheless, learning to read is not a linear but rather dynamic process that varies through the lifespan (Davies et al., 2017; Liu et al., 2024; Locher & Pfof, 2020). In this subsection, we

will adopt a developmental approach to reading, transversal to all the reading comprehension conceptualizations.

From the balanced trend, the RAND model states that “Learning to read well is a long-term developmental process. At the end point, the proficient adult reader can read a variety of materials with ease and interest, can read for varying purposes, and can read with comprehension even when the material is neither easy to understand nor intrinsically interesting” (Snow, 2002, p. 13). Close to this perspective, Alexander (2005) adapted the Model of Domain Learning (MDL) (Alexander, 1997, 2003) to reading. The MDL is a developmental theoretical framework that describes three stages when learning about a specific domain: acclimation, competence, and proficiency/expertise. Each stage focuses on the trajectories and interrelations between three forces: subject-matter knowledge, interest, and strategic processing. These forces are similar to the ones described by the PCCT under the Person component. The MDL focuses specifically on the development over the meso-time (how students evolve during their lifespan) and highlights the role of the context in the figure of educators that can scaffold learners. Tailored to the reading domain, Alexander (2005) describes: reader’s knowledge, interest and reading strategies.

Reader’s knowledge. This force refers to the acquired knowledge of the reader, mainly categorized as domain and topic knowledge. *Domain knowledge* reflects a reader’s overall reading ability (i.e., linguistic knowledge), while *topic knowledge* refers to how deeply they understand particular reading-related areas, such as main ideas, syllables, sound-symbol relationships, or text genres (Alexander et al., 1991). These dimensions are considered complementary and evolve at similar rhythms. Knowledge of specific topics can enhance overall reading ability by expanding vocabulary, grammatical understanding, and syntactic awareness. Conversely, stronger domain knowledge facilitates the acquisition of topic-specific

knowledge by making texts easier to comprehend (Alexander et al., 1994; McCarthy et al., 2018).

Readers' interest. This force refers to the drive of the reader and the underlying needs or desires. From a motivational perspective, research has identified two different, and often competing, forms of interest: individual and situational (Bergin, 1999; Hidi, 2006). Individual interest refers to a person's enduring motivation or sustained engagement with a particular subject. In contrast, situational interest is a short-term curiosity or focus sparked by features of the immediate environment. These forces tend to have an inverse relationship: as an individual's internal motivation and enjoyment for reading (individual interest) increase, the influence of external factors like context or task features (situational interest) tends to diminish. In the other direction, when a reader still has not developed individual interest, situational interest will have a higher influence (Hidi & Renninger, 2006). Reader's interest plays an important role as it can energize the reader's efforts even when they do not count with great reading knowledge.

Reading strategies. Strategies refer to broad cognitive approaches that individuals use to carry out tasks, such as making predictions, asking questions, or summarizing information. They also include the ability to monitor and control one's own learning and performance (associated with metacognition and self-regulation skills). Alexander (2005) highlights two forms of strategic processing: surface-level and deep-processing strategies. *Surface-level reading strategies* help readers initially access and understand written or spoken texts. These include actions like rereading, changing reading speed, or skipping over unfamiliar words. By contrast, *deep-processing strategies* involve actively engaging with the content by personalizing or transforming it. This might include comparing texts, creating visual representations, or critically evaluating the source. The use of these strategies presents an inverse relationship, linked to the amount of the domain and topic knowledge acquisition. At early stages, with no

abundant prior knowledge, the reader will rely more on surface-level strategies, without the required skills to engage in deep-processing strategies. Conversely, as the reader acquires more domain and topic knowledge, the use of deep-processing strategies becomes more evident.

As mentioned, these three forces vary in their trajectories and interrelationships through the three stages of reading development. In Figure 1.5 the stages described by the MDL (acclimation, competence and proficiency/expertise) and the forces' trajectories are graphically represented. Next, we will describe each stage:

Acclimation. In the acclimation stage, individuals are just beginning to learn how to read. Their domain knowledge base is low. While they might have some topic-knowledge (e.g., knowledge from some specific topic of their interest), their overall grasp of the domain is rudimentary. Because of this fragile knowledge, readers in the acclimation stage often struggle to differentiate important from trivial information and relevant from irrelevant content. They encounter many tasks that are novel and cognitively demanding, requiring substantial strategic effort. Their strategic repertoire is dominated by surface-level strategies, which help them cope with unfamiliar texts but rarely foster deep understanding. Interest at this stage is typically driven by situational factors (e.g., instructor efforts on presenting engaging texts, appealing formats, or novel contexts), rather than a developed, internalized motivation towards reading (individual interest).

Competence. As individuals transition to competence, they begin to develop a more cohesive and structured base of domain and topic knowledge. Their understanding becomes more interconnected and principled, allowing for more effective application of strategies. Strategic processing shifts from surface-level to more efficient and deep-processing strategies, supported by growing familiarity with the domain. Readers demonstrate increased automaticity in basic tasks, freeing cognitive resources for more complex comprehension and analysis.

Motivationally, competent individuals begin to rely less on situational interest and more on internally driven individual interest. This intrinsic motivation supports their pursuit of knowledge beyond required curricula, a key step toward developing deeper expertise.

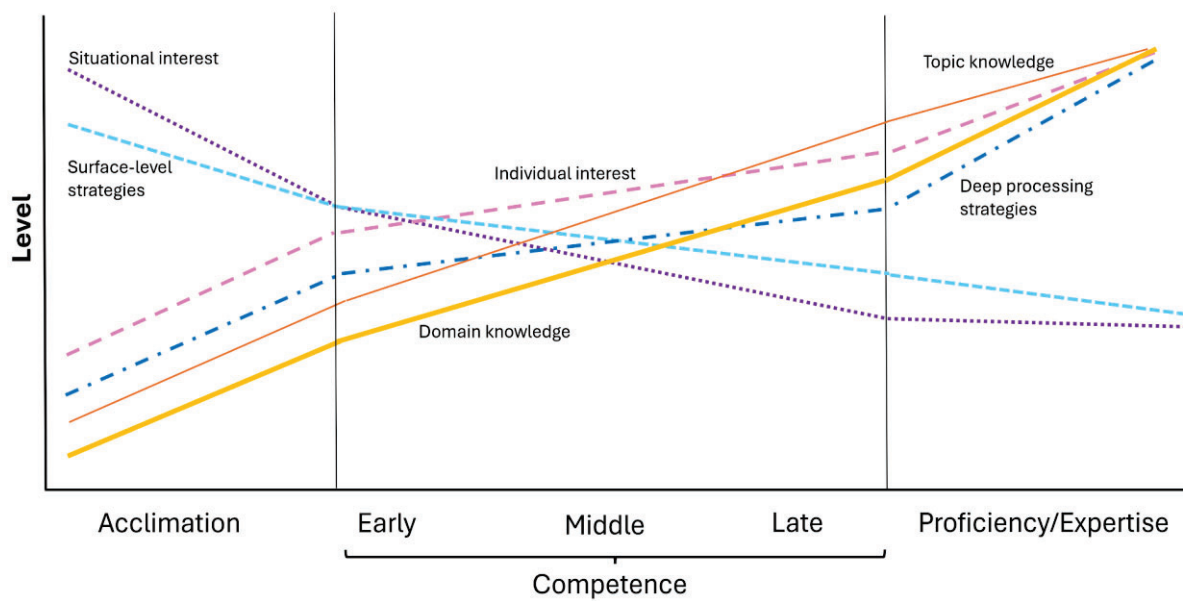
Proficiency/Expertise. At the proficiency or expertise level, individuals possess highly integrated and extensive knowledge of the domain. Their strategic skills are sophisticated and predominantly deep-processing, allowing for fluent, automatic performance on routine tasks and focused attention on complex problem-solving and inquiry. Experts are characterized by their ability to identify and explore new problems within the domain, contributing original insights and expanding the field's boundaries. Their individual interest is both intense and enduring, enabling sustained engagement despite challenges. Subsequently, the situational interest does not have high influence on the learner. This high level of personal investment is a hallmark of expertise, supporting continuous learning, innovation, and domain-specific creativity.

Alexander (2005) emphasizes that individuals can occupy any stage of domain learning at various points throughout their lives. Nevertheless, becoming an expert in any domain requires of further efforts and cannot be achieved in all knowledge domains. By the end of secondary school, we can expect that students show a middle to high competence level in mainstream academic domains, like reading (Alexander, 2003). Therefore, due to the widespread nature of compulsory schooling (World Policy Analysis Center, n.d.), the initial stages of reading comprehension development (acclimation and competence) are likely to occur primarily during preschool, primary, and secondary education. Educators need to be aware of factors that can benefit or hinder students' reading comprehension development through these stages. As such, in this doctoral dissertation we focus specifically on late primary

school students and how external factors, such as digitalization, may influence their reading development.

Figure 1.5

Stages of reading development according to the Model of Domain Learning (Alexander, 1997)



Note. Adapted from Alexander (2005).

In the next section, we will focus on how digitalization has introduced new reading habits and further reading comprehension conceptualizations. We will describe the evolution of reading habits assessment and the current trends of students' reading habits worldwide. Lastly, we will revise emergent theoretical models that aim to explain the specific cognitive processes involved in digital reading.

1.2. The digitalization of reading

A common aspect between the PCCT (Bronfenbrenner & Morris, 2007) and the RAND model (Snow, 2002) that differs from previous theoretical models is the explicit role of historical

moments on the individual's development. Human history has witnessed important inflection points, often marked by Industrial Revolutions. The First Industrial Revolution began in the late 18th century and continued through the 19th century. This period marked a profound shift from manual labour and agrarian economies to industrialized and mechanized processes. From the late 19th century to the mid-20th century, during the Second Industrial Revolution, the emergent inventions continued improving and advancing. Some of these advances included electrical and combustion energy engines, steel production machinery, and communications technologies, such as the radio, television and telephone. By the second half of the 20th century, there was a Third Industrial Revolution which is also known as the computer or digital revolution. This revolution was characterized by the proliferation of computers, automation, and the rise of information technology, especially with an increased accessibility to the Internet. Facing the fast development and increasing usage of digital systems, some experts support that at the current times we are at the early stages of the Fourth Industrial Revolution (Schbaw, 2016). Accordingly, this era would have started at the beginning of 21st century and is experiencing a notable acceleration around 2010, marked by the advance of artificial intelligence (AI), 3D printing, the Internet of Things (IoT), advanced robotics, and biotechnology.

Developmental researchers have tried to understand the role of technology in our lives, leading to the creation of new concepts based on the PPCT Context component. Specifically, some researchers consider technology as an immediate micro-system that directly influences child development (e.g., the *techno-sub-system* by Johnson and Puplampu, 2008). Others conceive technology as part of a virtual micro-system, different from the one face-to-face (Navarro & Tudge, 2023). In both cases, technology is broadly conceived as a means to access and produce information, communication and entertainment. This technological progress has introduced new types of reading media and content, leading to the development of new reading

habits. To describe this evolution, we will now expose how reading habits can be classified and understood.

1.2.1. Evolution of reading habits conceptualization

Research about reading habits dates back to the mid-20th century (Jordan, 1942). While some characteristics of reading habits have remained unaltered, others have evolved significantly in the last decades. Reading habits have been commonly described by their context, purpose and content. By the end of the 20th century and beginning of the 21st changes in reading habits demanded for a new category referring to the reading container, mainly referring to different reading media that goes beyond print.

Table 1.1

Reading habits classification based on Baron (2020) and its relation to RAND model components (Snow, 2002)

	Reading habits classification			
Baron (2020) categorization adapted to children's reading habits	Reading context* - In school - Out-of-school	Reading purpose (function) - For leisure - For academic goals	Reading content - Genre - Format - Length - Interactivity	Reading medium - Print - Digital
RAND model relation (Snow, 2002)	Sociocultural context	Reading activity	Text	

Note. The asterisk indicates the dimension added to the original Baron (2020) classification.

In Table 1.1 we provide a summary for this classification, and we relate it to the RAND reading comprehension components. It is worth noting that the proposed classification has been specifically tailored for school students and has been mainly based on Baron's (2020) classification of reading research variables that refer to descriptive characteristics. For that reason, the "reading context" category has been added to this list, based on previous research (that we will further detail). Next, we will explain each category, how they are interrelated, and highlight the changes propelled by digitalization.

Reading context. This refers to the place where the reading activity is performed. Generally, this context is labelled as in-school (i.e., inside the educational setting) or out-of-school reading (i.e., home, library, a friend's or relative house...) (Anderson et al., 1988; OECD, 2019). This distinction is important since reading is actively fostered in different contexts (e.g., at home, at school), by different means. While in-school reading typically follows a structured instructional approach, out-of-school reading is largely self-directed by the reader (Hong et al., 2004). This dimension is related to the sociocultural context described by the RAND model, representing the influences of the environment on the reader and reading habits. For example, at school, beyond the teacher instruction, the peers can also influence the readers' habits regarding trending topics (e.g., reading content that is more popular at a certain time) by talking and sharing common reading experiences (Howards, 2008). Outside school, the reader's home characteristics can also define reading habits. For example, if the reader's household counts with sufficient literary resources (e.g., number of books) the reader can have more opportunities to read (Gustafsson et al., 2011). At the same time, parents can also model their children's reading habits, by actively engaging in shared reading practices or just by acting as role models (Merga & Roni, 2018).

Purpose (function). Closely related to the context, Baron (2020) refers to the reading function. To highlight the motivation that drives the reading habit, we refer to reading *purpose* instead. It refers to the ultimate reading goal or reason to engage in the reading (Baron, 2020), as described by the reading activity component of the RAND model (Snow, 2002). Two main purposes have been identified referring to children's reading habits: reading for leisure (i.e., reading for entertainment) or reading for academic goals (i.e., as part of the homework or exam preparation) (Lupo et al., 2017; McKenna et al., 2012).

While context and purpose can be somewhat aligned (e.g., leisure reading outside school and academic reading inside school), these categories can be combined. For instance, reading for leisure inside of school (Teravainen-Goff & Clark, 2019) or reading for academic purposes at home (OECD, 2019). This fact can lead to some research gaps or over generalizations when referring to only one of the categories. For example, referring only to out-of-school reading can involve reading for leisure but also reading for academic reasons. Additionally, caution is advised, as some researchers use “leisure reading” to refer to reading during free time. If not specified, reading during free time can also entail academic reading and not only reading for entertainment and enjoyment (Locher & Philipp, 2023).

Reading content. Reading content refers to *what* is being read. According to Baron (2020), in this category we find sub-categories such as genre (e.g., fiction, non-fiction, poetry, reports...); format (e.g., book, article, magazine, comic...); length (i.e., number of words or pages); and lastly, interactivity (i.e., how the reader manipulates the information displayed). The reading content depends greatly on the **Reading Medium**. This category refers to the physical medium in which reading content is displayed. Already in 2002, Snow outlined differences on the “Text” component depending on the reading media (e.g., print vs. electronic texts) in the RAND model. Later theoretical paradigms expanded on this idea, particularly referring to the

embodiment in reading comprehension (Mangen & Schilhab, 2012). The embodied view of reading focuses on how the multisensory experience of reading differs according to the reading media, highlighting content features such as interactivity. Accordingly, research differentiates between two reading media: print and digital (Baron, 2020).

For decades, reading habits were only conceived in print media, thus, reading content was primarily represented by the reading of: books, newspapers, magazines and comics. These main categories of *format* have remained practically unchanged from almost a century. See for example Jordan (1942) review, in which he examined children's reading interests and habits from studies published between 1935 and 1939. Nowadays, researchers still refer to the same format categories for print (e.g., McGeown et al., 2016; Pfof et al., 2013; Torppa et al., 2020), even though some studies also include poetry and songs' lyrics (e.g., Duncan et al., 2016). Additionally, some researchers refer to the *genre* or topic of the books. Such categorization can be broad, for example fantasy vs. no-fantasy or factual books (e.g., Duncan et al., 2016; McGeown et al., 2016; Pfof et al., 2013; Torppa et al., 2020), or it can refer to specific thematic areas such as adventures, horror, romance, comedy, crime, etc. (e.g., Colles & Hall, 2002).

While the enduring nature of print reading has proven largely impervious to change, the digitalization of text and the new possibilities offered by digital media have significantly expanded the range of reading *content* available to readers in the last two decades. Researchers from the 80's first started to examine digital reading media using computer and TV screens (specifically they referred to Visual Display Terminals or Units) (for a review see Dillon, 1992). As Dillon (1992) predicted, nowadays, we have surpassed the limitations in digital devices that were present at his time, such as portability and eye-friendly visual display. In current times, the variety of digital devices that we can access to has expanded greatly, improving the quality and properties of the screens for reading (i.e., laptops, tablets, smartphones, e-readers...). Thus, the content to which readers can access now include new

genres such as webpages; new formats such as blogs, social-networks, shopping or educational platforms; and new forms of interactivity (i.e., hypertext, online-responses, drop-down menus...) (Baron, 2020). Furthermore, the reading media shapes how the content is displayed. In print media, the text is static, it remains fixed and finite, offering a contained reading experience (Mangen & Schilhab, 2012). Beyond basic activities like highlighting, writing in the margins, or adding post-its, there is little opportunity for interaction or distraction. In contrast, digital content is ephemeral, constantly changing and often presented in a short, fragmented format (van Moort et al., 2025). In section 3, we will also discuss how these changes on reading media and content are influencing reading comprehension development.

All in all, reading habits can be examined depending on the reading context, purpose, content and medium. One might ask why we need so many categories and dimensions to define reading habits. The truth is, as we will see, that these categories can help to guide more accurate reading habits assessments. In turn, these can help to disentangle complex relationships between reading habits and reading comprehension development (this will be further developed in the three studies presented in this thesis). Recognizing fundamental differences between print and digital reading habits is crucial for accurate measurement. If we only assess how much a student reads novels, whether in print or digital formats, we risk adopting a reductionist perspective (McKenna et al., 2012).

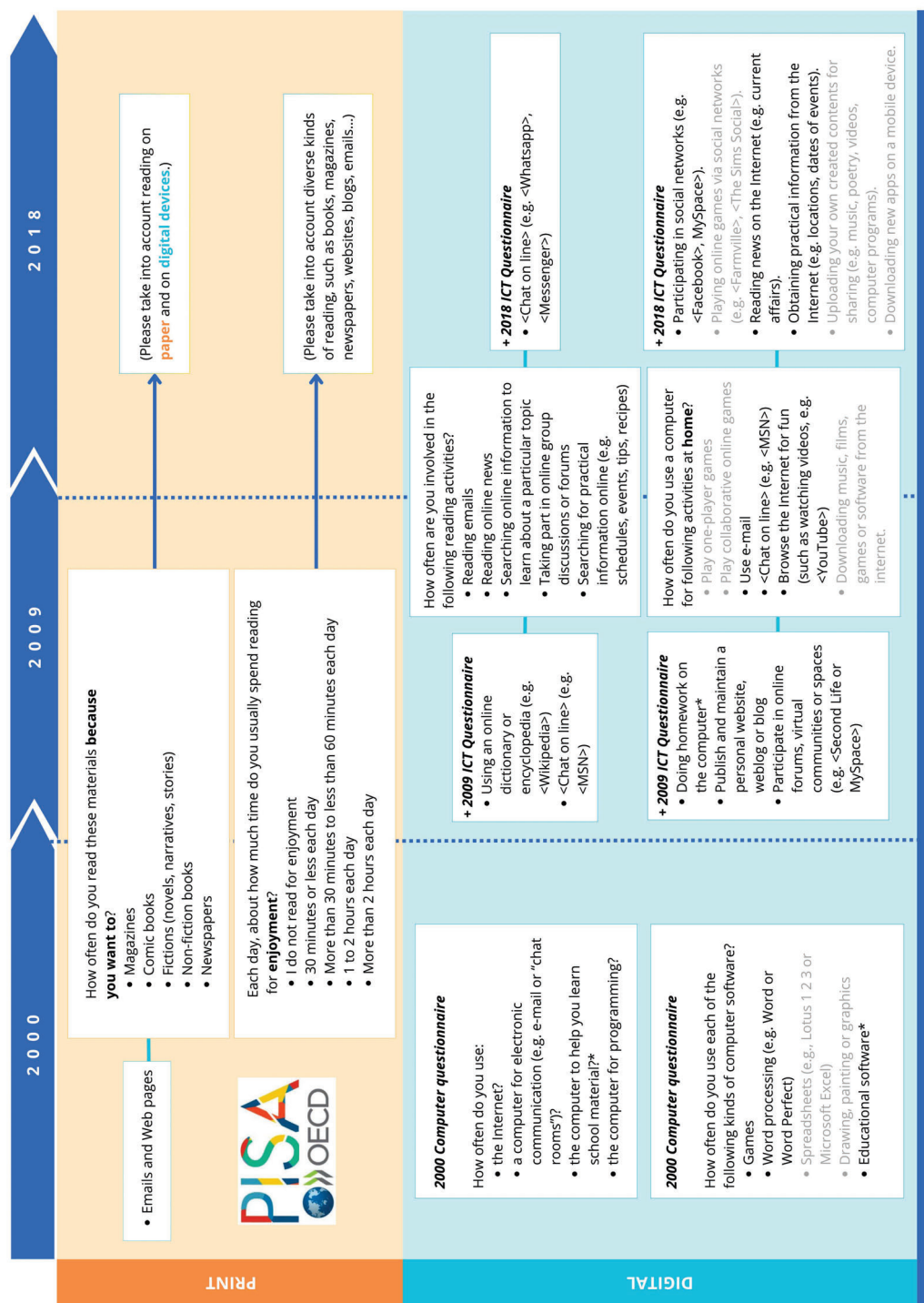
As we have seen, digital reading habits extend beyond the mere static reading of text on a screen, encompassing an interactive and dynamic reading activities that are not feasible in print. Over the past decades, research has reflected the progressive shift in reading habits characteristics. One representative example is the case of international large-scale assessments like PISA and PIRLS. These two large-scale assessments typically gather information about the participants beyond performance. Beyond performance, these assessments also focus on reading habits. By examining the change in the items employed by PISA and PIRLS since they

were implemented, we can get an overall impression of how sociocultural context, and the progress of digitalization have influenced reading habits. Next, we will focus on out-of-school leisure reading habits, distinguishing between print and digital reading media. Of note is that items assessing print academic reading out-of-school are not really present in these types of assessments. Nevertheless, items that could reflect this dimension are marked with an asterisk. Figures 1.6 and 1.7 present a comparative overview of these changes. Figure 1.6 illustrates the evolution of reading habits items in PISA, with a focus on the years in which reading competence was the main assessment domain. Figure 1.7 represents the evolution of reading habits items employed in PIRLS in all of their available editions. In PISA assessment, the 2000 and 2009 questionnaires' editions maintained a clear distinction between print and digital reading. By 2018, these were combined into a unique item that only referred to general reading frequency, independent of the medium. Although not depicted in Figure 1.6, 2018 PISA questionnaire placed a strong emphasis on the amount of reading occurring in each medium rather than the content itself. In this case, students were asked how they typically read books and news, whether on paper, digitally, or equally on both.

One of the most salient features in recent PISA assessments is the growing number of items related to digital reading. In 2000, all digital reading items referred specifically to reading on a computer. By 2009 and 2018, the list had expanded significantly. Some items were unique to specific editions, while others remained consistent. For example, in 2009, one item measured the frequency of participation in “online forums, virtual communities, or spaces (e.g., <Second Life® or MySpace™>).” In 2018 this item was replaced by a new one referring to “participating in social networks (e.g., <Facebook>, MySpace).” This shift highlights how technological advancements and emerging trends shape the reading experiences of students over time. While social networks were not explicitly referenced in 2009, early social platforms were already gaining traction, eventually becoming a representative reading habit. A similar

Figure 1.6

PISA items assessing reading habits by reading media (2000 to 2018: reading competence main editions)



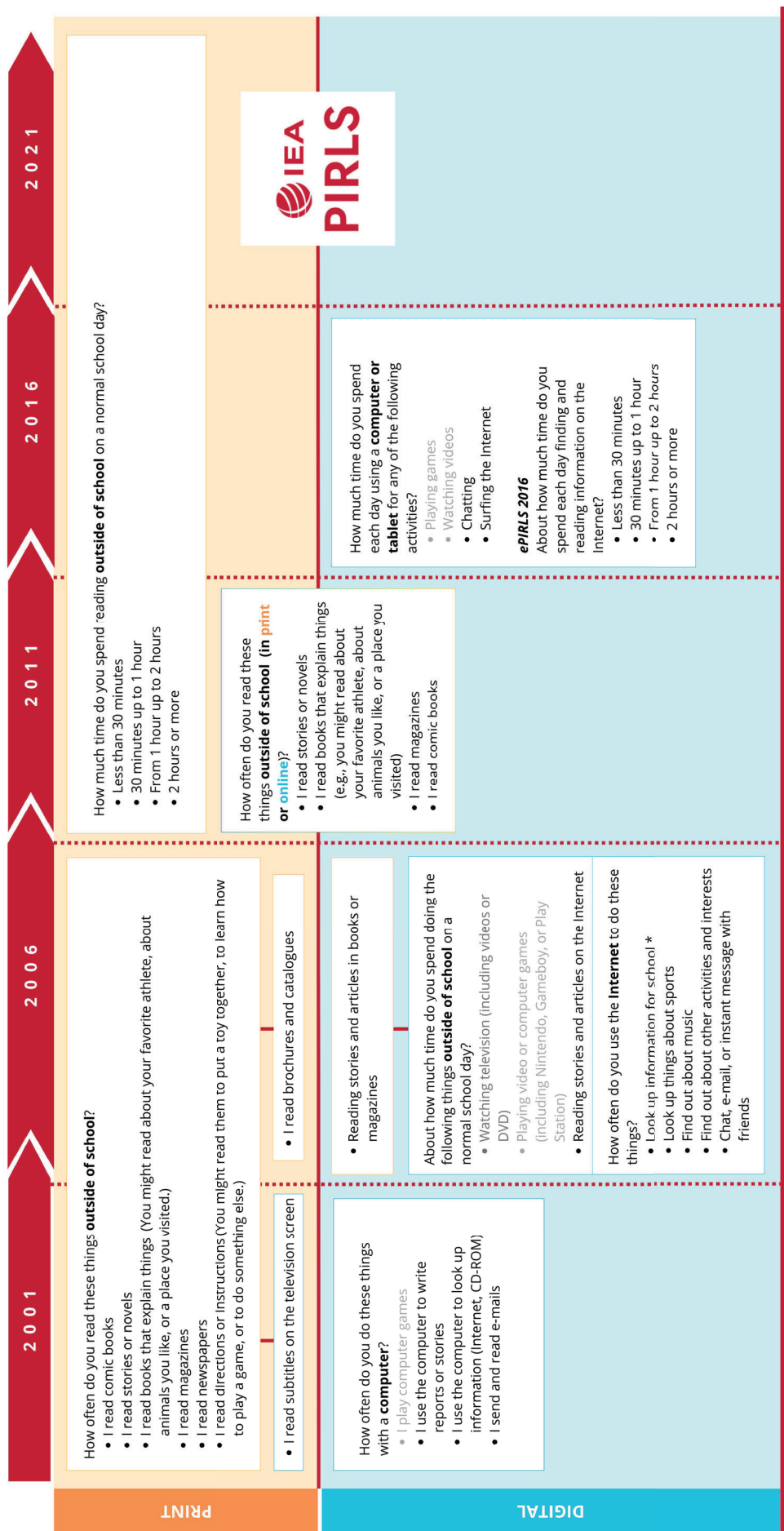
Note. Data extracted from PISA context students' questionnaires (OECD, 2000, 2009, 2018).

trend occurred in the PIRLS assessment. First, items referring to print were initially more specific, listing various reading materials and genres in 2001 and 2006 (e.g., comics, novels, books, magazines, instructions). Over time, these items became more generalized, with less detailed items and more broad questions referring only to overall frequency. Simultaneously, the items measuring digital reading continued to evolve, shifting from “computer” (2001) to “internet” (2006) and later to “tablet” (2021). Notably, in 2011, just a year after the launch of the first iPad, PIRLS stopped distinguishing between print reading activities and instead introduced a combined out-of-school reading frequency item (print and online). By 2021, the focus on reading habits diminished significantly, with only one generic item about reading frequency and without explicit items assessing print nor digital formats.

A final point worth mentioning regarding digital reading habits is the challenge posed by some assessment instruments, which are often too broad. While print reading scales in PISA and PIRLS are generally referred to as measuring “reading frequency,” they lack specific items or scales dedicated solely to measuring “digital reading frequency.” At the same time, in the Computer and ICT questionnaires used by these assessments, most items do involve reading (e.g., searching for information, reading online news, reading and sending emails). Yet, because digital devices serve as a multifaceted tool encompassing a wide range of activities, some of these items do not necessarily pertain to reading (e.g., listening to music, watching films, using digital canvases, playing video games). These non-reading items are coloured in light grey in Figures 1.6 and 1.7. More information regarding reading habits measurement will be presented in Chapter 3.

Figure 1.7

PIRLS items assessing reading habits by reading media (2001 to 2021 editions)



Note. Data extracted from PIRLS context students' questionnaires (IEA, 2001, 2006, 2011, 2016, 2021).

1.2.1.1. Students' trends reading habits

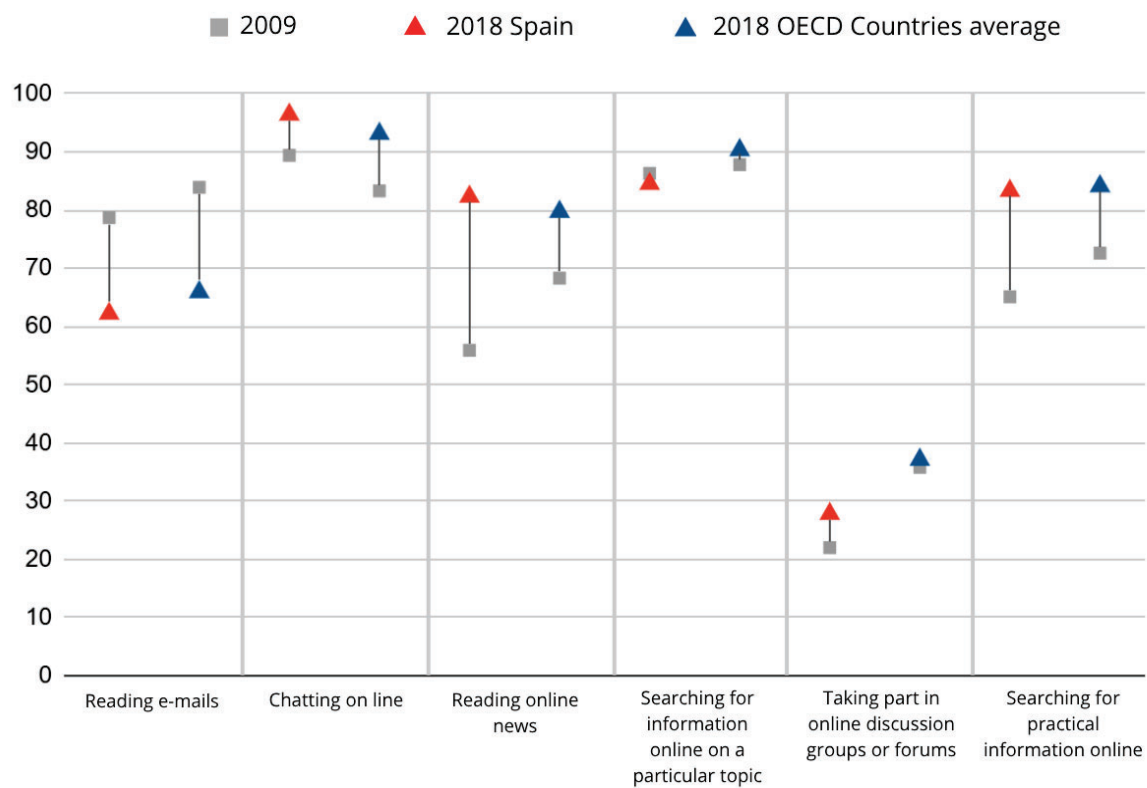
Because PISA has maintained the same items during 2009 and 2018 assessments, it is possible to make a temporal comparison of the reading habits of students' cohorts. In Figure 1.8 we can obtain a visual temporal comparison of the percentage of students that indicated that they read each listed content several times a month because they wanted to (i.e., for leisure). The graph presents Spain and OECD countries average data, to better contextualize the present doctoral dissertation. Overall, from 2009 to 2018 the number of students that indicated reading digital content has increased, although following different patterns. For example, chatting online was already a very common digital reading content in 2009, especially for Spanish students (Spain= 89.4%, OECD average= 83.3%). In 2018 the percentage of students that indicated reading this digital content grew +7% in Spain and +9.8% on the OECD countries. This high peak contrasts with the decreasing rates of students reading emails in 2018 (Spain= 62.2%, OECD average= 65.9%), when in 2009 it was still a quite popular reading content (Spain= 78.7%, OECD average= 83.9%).

Other types of social reading, like discussing in online groups or forums, show a slight increase from 2009 to 2018. This is specially the case for Spanish students (2009= 22%, 2018= 27.8%) that still present lower rates than the OECD countries (2009= 35.8%, 2018= 37.1%). Regarding reading news online, in 2009 only 55.9% of Spanish students indicated they read news online several times a month, while in 2018 this percentage grew up to 82.3%. This is in contrast with the OECD countries, which in 2009 presented a higher average percentage compared to Spain (OECD average= 68.3%) and in 2018 increased to a lesser extent, up to 79.7%. A similar pattern can be identified regarding searching for practical information online. With very similar percentages in 2018 (Spain= 83.3%, OECD average= 84.1%), Spain showed a bigger increase in the percentage of students that indicated reading this digital content than the OECD countries average in 2009 (Spain= 65.1%, OECD average= 72.6%).

Lastly, we also observe high frequent digital content that has shown no apparent change, such as searching for information online on a particular topic, from 2009 (Spain= 86.3%, OECD average= 87.8%) to 2018 (Spain= 84.5%, OECD average= 90.3%).

Figure 1.8

Percentage of students that indicated reading several times a month, Spain and OECD countries average from 2009 and 2018 (digital content)



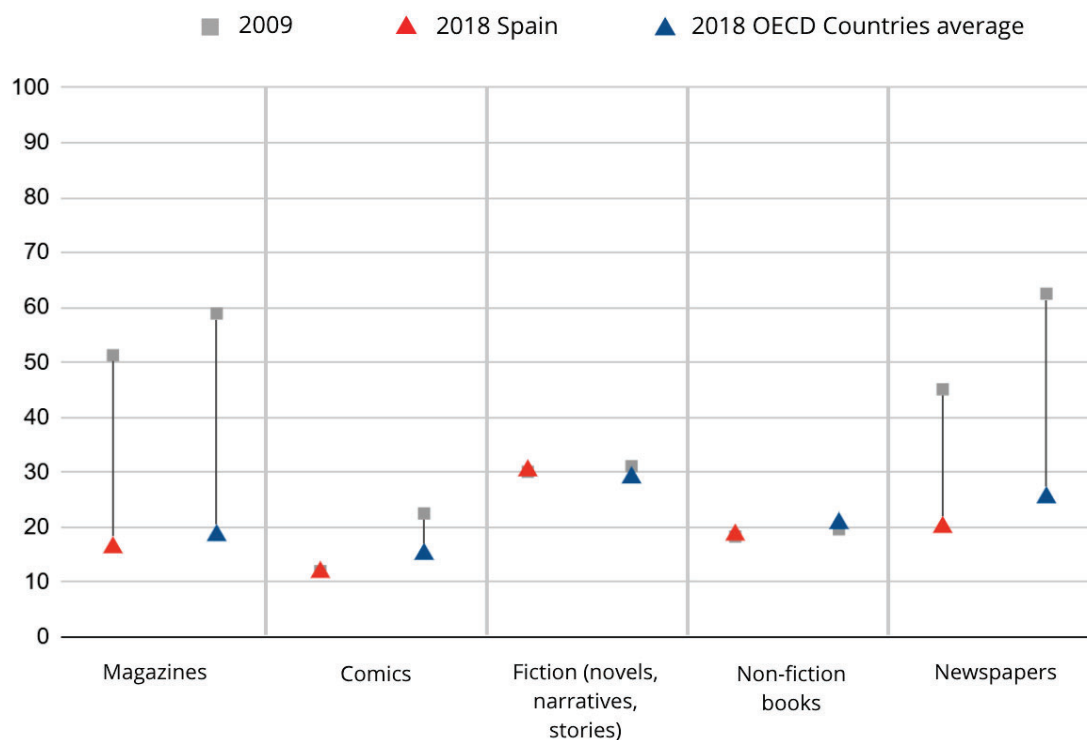
Note. Graph created from data in Tables I.B1.57 and I.B1.58, Annex B, in OECD (2019).

Unlike digital reading habits, print reading habits show overall low frequencies. In Figure 1.9, we compare the percentage of students from Spain and OECD countries average that indicated reading several times a month a list of print reading contents. Importantly, PISA questionnaire in 2018 did not distinguish between print or digital format of these materials.

Even though the category of print reading is not “pure” for 2018, the declining trends indicate an overall decrease in print reading altogether. On average, in 2018 less than 30% of students indicated that they read print contents several times a month. Spain shows stable rates between 2009 and 2018 in comics, fiction and non-fiction books (between 12 and 30% students). OECD countries show similar stable percentages (between 15 and 31%), and a slight decrease in comic reading from 22.5% to 15.1%.

Figure 1.9

Percentage of students that indicated reading several times a month, Spain and OECD countries average from 2009 and 2018 (print content)*



Note. Graph created from data in Tables I.B1.57 and I.B1.58, Annex B, in OECD (2019). *PISA questionnaire in 2018 asked “How often do you read these materials because you want to? (Please take into account reading on paper and on digital devices)”

Regarding magazines and newspapers' reading frequency, the percentage of students indicating that they read these contents several times a month has decreased significantly at similar rates in both Spain and OECD countries. In 2009 more than half of students indicated reading magazines several times a month (Spain=51.3%; OECD average= 58.9%). Nine years later, less than a fifth of the students indicated this (Spain=16.3%; OECD average= 18.5%). Similarly, in 2009 newspapers were read by 45.1% of Spanish students, while by 62.5% from OECD countries students. In 2018, these percentages dropped, with OECD countries showing a larger decrease (25.4% in 2018, 37.1% difference with 2009 rates) than Spain (20% in 2018, 25.1% difference with 2009 rates).

As we have reviewed, digitalization has promoted the emergence of new reading habits and new forms of reading habits assessments over the last decades. The shift in reading activities has created the need to also update reading comprehension models to explain how readers process the information from digital reading environments. Next, we will address the theoretical advancements and subsequent assessment adaptations in reading comprehension prompted by digitalization.

1.2.2. Reading comprehension conceptualizations in the digital landscape

The combination of the RAND model for understanding reading comprehension (Snow, 2002) and the PPCT model (Bronfenbrenner & Morris, 2007), which highlights the interaction within different contexts over time, had led to a comprehensive and balanced conceptualization of reading comprehension development in the beginning of the 21st century. As we entered the Third and Fourth Industrial Revolutions, emerging digital reading habits began to draw increasing attention from researchers. Because human behaviour evolves alongside technological advancements, new theoretical and assessment approaches are essential to effectively study and understand these changes, not only in behavioural aspects (i.e., reading

habits), but also in their cognitive aspects (i.e., reading comprehension). In this context, digital reading comprehension has become a key area of investigation, requiring a clear definition to distinguish it from traditional reading comprehension.

Through time, different definitions of digital reading comprehension have emerged, and several attempts have been made to unify this construct. The difficulty in defining this concept arises from the fact that digital devices can replicate almost identical formats of print reading but also offer activities that are inherently not possible in print. For example, a person can read a printed book or an e-book in electronic format. In both cases, the text is static and requires similar comprehension strategies, making this type of reading fundamentally offline (Leu et al., 2013). Nevertheless, nowadays, reading a static text on a screen is only one of the many reading activities available for readers, as we have reviewed previously regarding how the digital reading container has influenced the reading content. This influence has also changed how we conceive “texts”. Inspired by the RAND model (Snow, 2002), Coiro (2021) proposed a revised definition within a newly conceptualized framework for reading comprehension. In this framework, (1) the Text component expands beyond static, single texts to include multimodal content. It incorporates interactive texts from multiple sources, embedded hyperlinks, search and navigation features, and multimedia elements (e.g., audio or visual animations). (2) The Activity component introduces tasks that involve searching for information in online spaces while critically evaluating it, such as assessing the argumentative quality or credibility of sources. (3) The Reader component slightly departs from the RAND model (2002) by considering sociocultural identities as intrinsic to the reader rather than the context, while still accounting for the cognitive and motivational aspects of reading. Lastly, (4) the Context, for Coiro, involves not only the experiences from the reader’s environments, but also the context of the activity (characteristics of the task, constraints); context of the text (referring to which medium or platform it is materialized) and, in an intermediate position

between text and activity, the response format (when readers are asked to demonstrate their understanding), which can include from traditional multiple-choice-questions to audio or video recordings, to extended elaborated answers.

To refer to the reading comprehension encountered in digital texts that are highly interactive, Leu et al. (2011) suggested the term “online reading comprehension”. Unlike offline reading, which follows a fixed structure, online reading often involves hyperlinked texts and multimodal content. This type of reading goes beyond traditional reading comprehension, requiring new skills, practices and strategies to effectively navigate digital spaces (Leu et al., 2011). Some researchers have explicitly identified that digital reading (in the online environment) is a multidimensional construct that involves navigating, integrating information, and critically evaluating the quality and trustworthiness of the content (Salmerón et al., 2018a; van Moort et al., 2025). Other authors also refer to some of these abilities and highlight the social aspect of online reading. For example, Leu et al. (2017) distinguish that for an adequate online research and comprehension processing five reading processes take place: (1) identify important questions (i.e., what the reader wants to know, the problem to be solved), (2) locate information (i.e., select the relevant information for the reading goal), (3) evaluate information (includes a critical evaluation of the accuracy, reliability, and bias of information), (4) synthesize information (i.e., integrate the information from several sources), and (5) communicate information (i.e., ability to seek information on the Internet or share what has been learnt).

It is worth remembering that the skills we have associated to digital reading are not new or strictly different from print reading. For example, Wieneburg (1991) described a set of heuristics that advanced readers (i.e., historians) use, including: corroboration (i.e., comparing documents), sourcing (i.e., checking the source of the document before reading it), and

contextualization (i.e., situating a document in a concrete temporal and spatial context). These heuristics are very similar to navigation and evaluation of online multiple documents described by Salmerón et al. (2018a) and Leu et al. (2017). Nevertheless, nowadays, the access to information is no longer exclusive for experts and digital reading significantly amplifies the demands on these skills, requiring sufficient knowledge to successfully process information in digital environments (Bruggink et al., 2025).

One key characteristic that has increased the cognitive demands in online digital reading, compared to traditional print reading, is the frequent need to engage with multiple texts to answer a specific inquiry. This is due, in part, to the technological advantage of easy access to information. While comparing and integrating information from multiple sources is possible in print, it is far more prevalent when reading on digital devices, where readers often encounter content from various websites or digital documents. This feature is highlighted by Coiro who has defined digital reading as “a range of multifaceted meaning-making experiences whereby readers engage with multiple [digital] texts for particular purposes that are situated in diverse contexts” (Coiro, 2021, p.12). Multiple document (MD) reading comprehension constitutes its own research line and has increasingly gained relevance in the digital age. Several models have been proposed to explain multiple documents reading comprehension, building on previous models like the CI and landscape models. MD models usually include a *task model*, referring to the perceived learning goals that the reader aims to accomplish, and a *documents model* which describes the perceived mental representation of the texts' information. The first MD models described the basic processes of constructing and integrating information across different texts, expanding the already consolidated CI model, such as the Document Models Framework (DMF; Perfetti et al., 1999). Later models highlighted the relevance of the task reading goal and the production of external products like the Multiple-Document Task-based Relevance Assessment and Content Extraction (MD-TRACE model; Rouet & Britt,

2011) or the Reading as Problem-Solving model (RESOLV; Britt et al., 2018; Rouet et al., 2017). This last model builds up on the MD-TRACE model, and explicitly includes the concept of a *context model*, highlighting the values associated with the reading goals. While the origin of these reading comprehension models has been propelled from the digital reading practices, some underlying mechanisms apply also to print reading. Particularly, the conceptualization of reading as a tool to solve problems.

Because one frequent challenge in MD reading is facing conflicting information, some theoretical models have focused specifically on this matter like the Discrepancy-Induced Source Comprehension model (D-ISC; Braasch, et al., 2012, Braasch & Bråten, 2017) or the Content-Source Integration model (CSI; Stadtler & Bromme, 2014). Lastly, in an attempt to unify and gather the information from previous models, List and Alexander developed the Integrated Framework of Multiple Texts (IF-MT; List & Alexander, 2019). This comprehensive framework differentiates across behavioural, cognitive, and metacognitive/regulatory strategies, influenced by affective predispositions. One relevant aspect in common across MD reading models is that they tend to conceive MD reading as a more authentic and prevalent reading scenario than single text reading. As Strømsø points out: “in modern societies, multiple source use is more often the rule than the exception, whereas only some decades ago multiple source use was primarily a matter of expertise” (Strømsø, 2017, p.8).

The proliferation of digital devices has influenced both what and how readers read. Beyond shaping the reading experience for test-takers, digital tools have also provided significant advantages for test-makers. Tests for digital reading comprehension include realistic reading scenarios, including hyperlinks and/or social elements such as comments in a blog, messages from a social network, or emails. Instruments such as *webLEC* (Salmerón et al.,

2018b) and *ORCA* (Caccia et al., 2019; Coiro & Kennedy, 2011) represent examples of this type of assessment, simulating online search engines and results that demand the reader to navigate, select, interpret and integrate the information in order to solve a contextualized problem.

Moving beyond punctual assessment sessions, technology facilitates gradual adaptation of assessments and feedback cycles. Scenario-Based Assessments (SBA) are an example of this type of methodology. Beyond the use of authentic scenarios, these assessments integrate multiple data sources, interactive tasks, and real-time feedback, making them a useful tool for both evaluating and fostering learning. One of the most representative examples in digital reading comprehension we can find nowadays is the Global, Integrated, Scenario-based Assessment (GISA), developed by the Educational Testing Service (ETS) (Sabatini et al., 2019). GISA presents students with real-world reading situations, requiring them to search, evaluate, and integrate information from multiple sources such as emails, articles, and charts. It also incorporates interactive and collaborative elements, simulating tasks like explaining reasoning to a virtual peer. At the core of formative assessment, GISA provides real-time feedback to students during the scenario-based tasks, meaning that it is not just a tool for measuring students' reading ability, but also a resource for supporting and improving their learning. GISA creation has been inspired by previous scenario-based and dynamic assessments such as *CBAL (Cognitively Based Assessment of, for, and as Learning)* (Bennett & Gitomer, 2009). As Valencia and Pearson (1987) praised, current SBA are designed to be part of the instruction with a formative approach. Therefore, they not only assess students but also enhance instruction as the educators receive continuous information about their students' progress. Although still not widely adopted, 21st-century formative SBAs can be considered in their infancy, with an increasing number of educators and researchers viewing them as the future of learning and instruction (Sabatini et al., 2019).

1.3. Reading habits and comprehension

The first two sections of this introduction have primarily described the conceptualization and assessment of reading comprehension and reading habits. This section will now examine how these concepts are interconnected, with a special focus on the current digital landscape, highlighting the research gaps that this thesis intends to cover. Because these topics are further elaborated in Chapters 2, 3 and 4, the literature detail is limited to avoid overlapping.

As discussed in section 2, reading habits have shifted beyond printed pages and are gaining popularity among young students. At the beginning of this introduction, we mentioned that there are growing concerns about the impact of digital reading, particularly regarding its effect on reading comprehension compared to print materials. There are two main reasons that fuel these worries. The first is the historical positive association between print reading habits and reading comprehension, and their decreasing trends nowadays. The second is the increasing trends on digital reading habits frequency and the growing literature highlighting how they can negatively influence reading comprehension. We will now elaborate on these reasons.

1.3.1. The role of print reading habits

Print reading habits have been extensively linked to better reading comprehension development in a wide range of ages, with supporting review and meta-analytical evidence (Allington & McGill-Franzen, 2021; Mol & Bus, 2011). These studies indicate that the more a person reads, the better their reading comprehension. The mechanism behind this improvement is related to the increased practice that the reader experiences and the subsequent acquisition of related knowledge that helps to comprehend (e.g., vocabulary, syntax and grammar), alongside the development of advanced cognitive strategies, such as making inferences, summarizing, and monitoring understanding (Guthrie & Wigfield, 2000; Liao et al., 2022). At the same time,

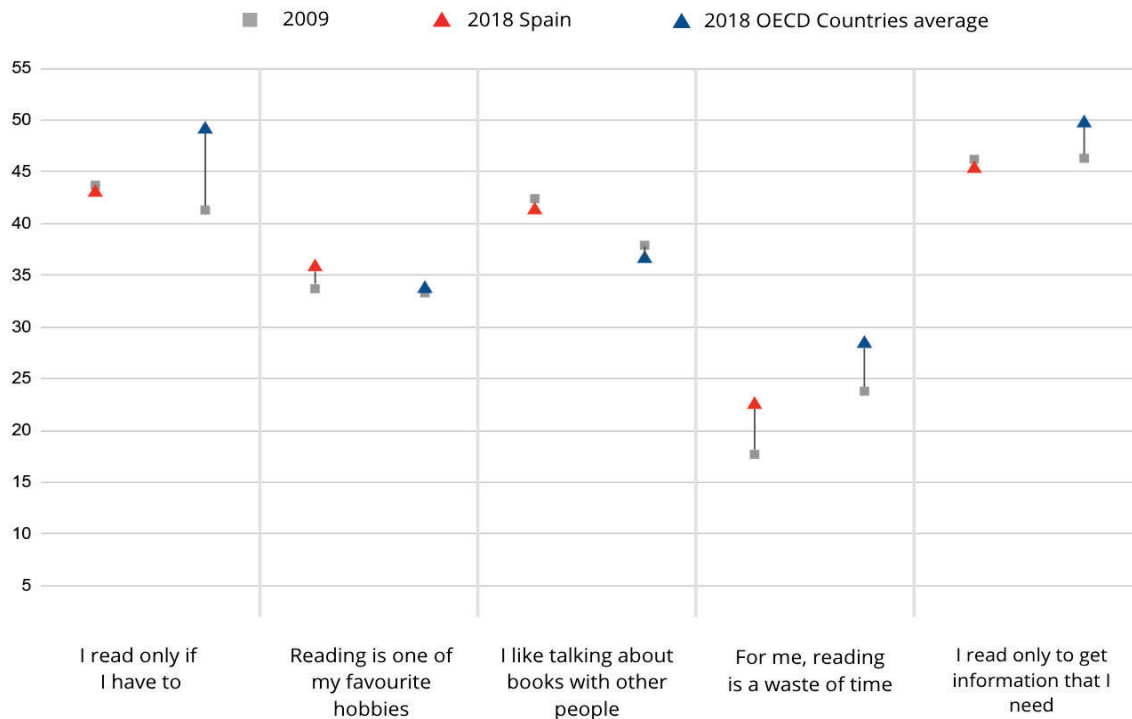
reading comprehension is also a positive predictor for print reading habits. Longitudinal and twin studies reveal that reading comprehension is even a stronger predictor for print reading habits than vice versa (Bittmann, 2024; Erbeli et al., 2020; van Bergen et al., 2020). The reason for this effect of reading comprehension on print reading habits frequency could be related to reading motivation.

Several theoretical models that we have described in section 1 highlight motivation as an important reader factor that can influence reading comprehension (e.g., PCCT, RAND model, landscape model, MDL). Indeed, motivation is described as the drive that energizes and directs our behaviour (Ryan & Deci, 2000), and has been positively related with reading comprehension by numerous studies (Schiefele et al., 2012). Particularly, intrinsic motivation refers to reading driven by personal interest, enjoyment, and the inherent satisfaction of the activity itself (Ryan & Deci, 2000; 2017). As the *virtuous circle of reading* describes (Locher & Pfof, 2020; Pfof et al., 2014), if a reader has good comprehension levels, they will be more likely to enjoy reading than a peer with poor reading comprehension levels. The pleasure of reading would then foster positive attitudes towards reading, promoting more frequent and engaged reading behaviour. Ultimately, this practice will benefit reading comprehension skills.

As we have outlined during section 2, print reading habits and overall reading comprehension levels are showing decreasing trends worldwide. Reading enjoyment (related to intrinsic motivation) is not an exception. In Figure 1.10 we present comparative data from the last PISA 2018 and 2009 assessments for Spain and OECD countries students. Overall, in 2018 approximately half of the students reported that they read only to get information that they need or that they read only when they have to. These rates represent an increment from 2009 data, where these rates were between 43 and 46%, respectively. In the case of Spain, such rates are lower and have experienced slight decrease between 2009 and 2018. Unlike OECD

Figure 1.10

Reading enjoyment frequencies, Spain and OECD countries average from 2009 to 2018



Note. The vertical axis represents the percentage of students that have agreed with the statements on the horizontal axis. Graph created from data in Tables I.B1.57 and I.B1.58, Annex B, in OECD (2019).

countries, 43.7% and 46.2% of students indicated that they read only to get information that they need or that they read only when they have to. In 2018 these rates decreased by 0.7 and 0.9 points in the percentages, indicating more stability in reasons to read than the OECD countries average. Similar to both Spain and OECD countries, in 2018 more students felt that reading is a waste of time (Spain= 22.5%, OECD average= 28.4%) than in 2009 (Spain= 17.7%, OECD average= 23.8%). Common to both years, Spanish students agree less with these claims, compared to OECD countries students. This is also reflected in the rather stable levels of reading enjoyment when talking about books with other people, with very slightly differences between 2009 (Spain= 42.4%, OECD average= 37.9%) and 2018 (Spain= 41.3%,

OECD average= 36.6%), in which Spain presents higher rates than OECD countries average. Even though the number of students that feel that reading is a waste of time has increased, still a notable amount of Spanish students state that reading is one of their favourite hobbies, with increasing trends (2009= 33.7%, 2018= 35.8%). By contrast, OECD countries show stable levels, below Spain's percentages (2009= 33.3%, 2018= 33.7%).

In light of global trends showing declines in print reading habits, reading comprehension, and reading enjoyment, digital reading habits have recently come under the spotlight.

1.3.2. The role of digital reading habits

In contrast to print reading habits, in section 2.1.1 we observed how digital reading frequency is continuously growing among students. Despite their increasing popularity, no meta-analytical study has yet examined the relationship between digital reading habits and reading comprehension. Nevertheless, concerns arise from the findings of cross-sectional studies indicating negative correlations between digital reading habits and reading comprehension (e.g., McGeown et al., 2016; Pfoest et al., 2013). Detailed information about these studies and more will be provided in Chapter 2 which presents a metaanalytical study on digital reading habits.

Additionally, experimental studies have consistently demonstrated the so-called "screen inferiority effect." This effect describes slightly worse reading comprehension associated with digital reading (e.g., computer, laptop, tablet, e-reader), compared to print, and has been outlined by several metaanalyses (Clinton, 2019; Delgado et al., 2018; Furenes et al., 2021; Kong et al., 2018; Öztöpe & Nayci, 2021; Salmerón et al., 2024). The experimental studies included in these metaanalyses typically involve reading the same plain text in either print or digital format and then assessing reading comprehension in each media. One of the most

recurrent explanations for such effect is actually related to how digital reading habits are promoting shallowing mind-sets (Annisette & Lafreniere, 2017; Carr, 2010). The *digital chain hypothesis*, proposed by Maryanne Wolf (2018), describes such changes in reading behaviour and processing. In section 2 we described how reading content greatly varies depending on the media that is displayed on. Wolf highlights that we are reading more than ever. However, the actual length of the content we eventually read tends to be short on digital devices. The reason is that the information abundance of the Internet can result in information being overwhelming. Related to the open changing nature of Internet-based reading and lack of spatial markers (Mangen & Shilab, 2012), some readers get “lost in the hyperspace”² (Otter et al., 2000). The way in which readers manage such amount of information is by reducing the devoted time and amount of reading. For example, readers might prefer to read only the summary from a blog instead of reading the full scientific article or let social media headlines guide their understanding of current events instead of reading the whole news page. In other words, readers are opting to read less and increasingly delegating cognitive effort to content that is “easier to digest”. Carr (2010) adds that this superficial action is driven by the current digital platforms, designed as transactional spaces. In these spaces, attention is currency and readers are both consumers and products. This is, most online platforms where readers access the content are primarily designed to generate revenue³. In order to maximize profit, these platforms rely on keeping readers engaged in a sequence of clicking as many links as possible (Carr, 2010). To

² This term refers to the feeling of disorientation or lostness when trying to navigate within hypertext systems. Previously, Elm and Woods (1985) had described this feeling as: “Getting lost in a display of networks means that the user does not have a clear conception of relationships within the system, does not know his/her present location...relative to the display structure, and finds it difficult to decide where to look next in the system.”

³ Nicholas Carr (2010) explains how Google, the most popular Internet-search engine, monetizes user data behaviour by selling this data to advertisement companies. The reason why clicks are important is that advertisers pay per click, being these the primary source of revenue for publishers (Rafieian, 2023).

achieve this, they employ various techniques, such as recommending related articles, videos, or other sources. This creates a tendency for readers to skim through the information, jump from one piece of content to another, often with little time spent on any one topic. Additionally, digital platforms are frequently cluttered with unrelated distractions, such as commercial ads, pop-ups, or links to “interesting” content. Such features prevent the reader from engaging in deep reading processes, usually perceiving a lack of sustained concentration when reading in digital media (Baron, 2017).

The core of the *digital chain hypothesis* lies in the long-term effects that engaging with information in such a superficial manner can have on readers' cognitive habits. Wolf uses the term “mental set” to refer to the habitual predisposition and approach with which readers engage with texts. In this context, if a reader spends a significant amount of time engaging in fast, skim-based, and shallow reading of short materials this reading pattern can extend to longer texts as well, even in print. Consequently, readers may struggle to shift to more demanding tasks that require deeper, sustained focus. Wolf describes this phenomenon as a “bleeding over” effect, where the habits formed during shallow digital reading spill over into other cognitive processes, such as working memory and sustained attention, ultimately hindering reading comprehension, as noted by Carr (2010). While this hypothesis provides a compelling theoretical explanation, currently, it lacks sufficient empirical support from longitudinal designs. Beyond the studies that examine reading comprehension in print vs. digital, only a few studies have explored how digital reading habits influence reading comprehension over time. Studies like the one of Torppa et al. (2020) have raised some concerns, as digital reading habits in grade 6 negatively predicted reading comprehension next year. This study represents a unique and first attempt to examine digital reading habits and reading comprehension longitudinal associations. Nevertheless, this study only focused on

leisure digital reading habits and did not explore further factors that could explain the longitudinal dynamics, such as reading motivation.

Contrary to print reading habits, the relationship of digital reading habits with motivation has not been examined in depth. Only scarce studies have attempted to examine this relationship. Findings from these studies, of cross-sectional nature, show that intrinsic motivation negatively predicts digital reading habits in secondary school students (McGeown et al., 2016). At the reverse direction, school-based interventions using digital devices indicate that they can increase students' reading motivation by promoting readers' interest (Webber et al., 2023). In spite of these structured interventions, students worldwide also read on digital devices, at home, and less is known on how these out-of-school habits can influence their reading motivation. Contrary to what digital-school interventions claim, the digital content and the habitual shallowing interactions could also hinder further reading motivation. Numerous studies indicate that readers typically prefer reading in print over digital media because they feel they can concentrate and engage better with the text (Baron et al., 2017; Liu, 2005; Mizrachi et al., 2018). These studies, aligned with the screen-inferiority effect, suggest that the characteristics of digital reading, such as the abundant available information and the lack of spatiotemporal markers, could have different effects on reading motivation. All in all, digital reading habits are still somehow underexplored and their relationship with reading comprehension and motivation is yet unclear. These relationships will be addressed in more detail in Chapter 4.

1.4. Summary and research questions

As outlined in this chapter, digitalization has transformed our understanding of reading comprehension and reading habits. Over time, definitions of reading comprehension have expanded to include multiple perspectives, emphasizing the various factors that can influence

it. One growing area of interest is the impact of reading medium, as digital and print formats present information in different ways, each with unique characteristics that can either support or hinder comprehension. The increasing presence of technology in everyday life has introduced new reading habits, beyond printed materials. In fact, international large-scale assessments show a global rise in students' digital reading frequency, alongside a gradual decline in print-based reading habits. These assessments also reveal a concurrent downward trend in reading comprehension and motivation across countries. Together, these trends highlight the pressing need to examine how evolving reading habits, particularly digital ones, are influencing the development of reading comprehension, a topic that has so far received limited attention. For instance, no meta-analysis has examined yet how habitual engagement with digital reading relates to reading comprehension. Additionally, few longitudinal studies have explored such relationship over time. To address such need, this dissertation pursued two primary objectives. First, it aimed to investigate the relationship between digital reading habits and reading comprehension from the existing literature. Second, it sought to explore the longitudinal associations among digital reading habits, reading comprehension, and reading motivation in Spanish primary school students.

Following these objectives, in Chapter 2 we present a meta-analysis (Study 1) that aims to provide a foundational overview of the literature on the overall association between digital reading habits and comprehension, thereby addressing our first objective. To fulfil the second objective, we present in Chapter 3 and 4 two empirical studies focusing on Spanish primary school students. In Chapter 3, we describe Study 2 which details the development and validation of a new instrument designed to measure children reading habits. Specifically, this instrument aims to capture the multidimensionality of reading habits, categorizing reading habits according to their reading purpose (leisure and academic) and reading media (print and digital). Study 2 describes the process of item construction, scale development, and

psychometric testing to ensure reliability and validity of the instrument. Lastly, in Chapter 4 we present Study 3 which examines longitudinal associations between digital reading habits (employing the instrument developed in Study 2), reading comprehension and reading motivation from Spanish students from grades 4 to 6. Together, these three studies sought to offer a comprehensive and multifaceted approach to understanding how evolving reading habits in the digital age relate to the development of reading comprehension over time.

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Chapter II



Study 1

Do new forms of reading pay off? A meta-analysis on the relationship between leisure digital reading habits and text comprehension

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Chapter II

Study 1 - Do new forms of reading pay off? A meta-analysis on the relationship between leisure digital reading habits and text comprehension

2.1. Introduction

Decades of research have evidenced solid benefits of reading habits in terms of reading comprehension development across the lifespan (Locher & Pfost, 2020; Mol & Bus, 2011; van Bergen et al., 2020). Evidence converges on the positive reciprocal relationship between reading practices and the development of reading comprehension skills (Stanovich, 1986). As young readers are exposed to increasingly longer and more complex texts, they further develop their ability to comprehend texts which, in turn, encourages them to pursue even more complex texts. Such a relationship, which has been established for habits involving printed texts, may be different for new forms of reading. Currently, reading not only takes place on paper. The growing evolution of digital reading devices, the constant access to such devices, and the new types of reading materials available (e-books, social networks, digital newspapers, etc.) have suddenly introduced new reading habits. In terms of leisure time, reading frequency for print materials has decreased in the last decade. A comparison of Program for International Student Assessment (PISA) data from 2012 and 2018 showed that adolescents voluntarily read fewer fiction books, magazines, or newspapers. On the contrary, they read more to fulfill their practical needs, and they read more using online formats, such as chats, online news, or websites containing practical information (e.g., schedules, events, tips, recipes; Organization for Economic Co-operation and Development [OECD], 2019). Studies suggest that the increasing access to digital devices is taking place at the expense of traditional reading of printed books (Merga & Roni, 2017). A national study examined data from 1,021,209 students

of eighth, 10th, and 12th grades in the United States, from 1976 to 2016 (Twenge et al., 2018). The authors support the displacement theory after evidencing a substantial decline in book leisure reading and a sharp growth of digital media consumption across all ages. As online texts tend to have rather low linguistic qualities (Snow, 2010) and are often created for quick and brief consumption, such an increase in digital reading frequency could impact readers' development of comprehension skills. Wolf (2018) has recently hypothesized that such an influence should be particularly evident during the early years of primary school, where the focus of reading instruction is still on developing reading foundations (decoding, fluency, or vocabulary) and not on reading to learn.

The emergent popularity of these new forms of reading has brought a renewed emphasis on the study of the relationship between reading habits and reading comprehension; however, to the best of our knowledge, no previous study has synthesized the existing literature. Therefore, we present a meta-analysis of recent studies that have specifically investigated the relationship between digital reading habits and reading comprehension, focusing on leisure reading (not motivated by academic or work-related purposes). In addition, we explore the effects of several potential moderator variables.

2.1.1. Print reading habits

Print reading habits usually involve reading novels, magazines, newspapers, or comics on paper. Such habits have been positively associated with reading comprehension development. In their meta-analysis, Mol and Bus (2011) studied the relationship between reading habits, measured by print exposure level, and reading comprehension skills from infancy to early adulthood. From the 99 studies analyzed, moderate to strong correlations were found (r for Grades 1 to 12 = .36), being the highest in higher-education readers (r = .41).

Potential underlying mechanisms for this relationship consist of a “virtuous circle of reading” in which time spent reading and reading comprehension are self-reinforced. One well-established model to explain such a relationship is the Matthew effect, by which “the rich get richer, and the poor get poorer” statement is applied to reading development (Pfof et al., 2014; Stanovich, 1986). In this way, children who are good readers tend to engage in more frequent and more challenging reading activities, thus enhancing their reading comprehension at a faster pace than poor readers, who usually do not find much pleasure in reading and thus improve their skills at a slower pace. Recent longitudinal studies have analyzed the influence of print reading habits on the development of reading skills throughout childhood (Torppa et al., 2020; van Bergen et al., 2020) and from preadolescence to later adulthood (Locher & Pfof, 2020), providing empirical support for a Matthew effect on reading.

2.1.2. Digital reading habits

As research on digital reading habits is still emerging, definitions of what constitutes such habits vary widely across studies. Definitions tend to emphasize purposes, text types, and reading frequency. Regarding purposes, authors tend to distinguish between academic or school and leisure reading habits (Torppa et al., 2020), also referred to as extracurricular (Pfof et al., 2014) or recreational (McGeown et al., 2016). Regarding texts, major types of digital texts distinguish between on-screen texts (non-interactive texts presented on digital devices such as tablets, or computers); and hypertexts and hypermedia (interactive and linked texts, which may or not be connected to the Internet; Coiro, 2021). Finally, digital reading habits are usually measured in terms of temporal frequency via self-reports (e.g., “How often do you read. . .?”). Accordingly, we define leisure digital reading habits as the time spent on digital texts for the purposes of social communication (e.g., instant messaging, online chatting, emailing, checking social media) or informative-linear reading (e.g., looking for information on the

Internet; browsing a website, blog or forum; reading e-books, e-magazines, or e-comics; Duncan et al., 2016; McGeown et al., 2016).

The emerging availability of digital reading devices during the 2000s, and the subsequent increase in leisure digital reading habits in the population, have raised concerns about the well-established relationship between reading habits and comprehension. Within the existing literature, we find evidence pointing in two opposite directions. On the one hand, longitudinal studies evidence a negative relationship between digital text reading habits (measured as reading frequency via self-questionnaires and parental reports in Grades 1 to 4) and reading comprehension skills at later ages (from Grade 6 to 7; Torppa et al., 2020). In a bidirectional way, lower reading comprehension predicts higher frequency of digital reading in earlier stages (from Grade 4 to 6). Cross-sectional studies also report negative relationships between digital reading habits and reading comprehension regardless of the purpose of reading: leisure activities (Naumann & Sälzer, 2017; Park & Weng, 2020) or academic tasks (Amiama-Espaillet & Mayor-Ruiz, 2017; Gumus & Atalmis, 2011; Park & Weng, 2020). Recent meta-analyses can help understand the mechanisms that are involved in these negative relationships, as they converge on the existence of a print-reading superiority effect. This phenomenon states that worse text comprehension is observed when reading on a digital device compared to reading the same text in print. This effect has been evidenced in older readers, from post-secondary students to undergraduates (Clinton, 2019; Delgado et al., 2018; Kong et al., 2018), and in pre-readers (Furenes et al., 2021). Even though the effect sizes are small (Hedges' g between $-.21$ and $-.25$), one could argue that, in the midterm, the detrimental effect of continuously reading on digital devices could prevent young students from fully developing their potential reading comprehension (Salmerón et al., 2023).

Two unique factors suggest that spending leisure time with digital reading tools may not pay off in terms of reading comprehension development. First, digital reading devices can

serve many different purposes other than reading, which incentivizes multitasking and distractions from reading (Baron et al., 2017), with potentially detrimental consequences for comprehension (Clinton-Lisell 2021; Liu & Gu, 2020; Nikkelen et al., 2014). Second, the Internet has brought new types of reading with particular features, such as short and fast-paced stimuli, low-quality content, and informal language. According to the Shallow Hypothesis (Annisette & Lafreniere, 2017; Carr, 2010) the frequent use of ultra-brief social media promotes rapid and relatively shallow thought, associated with cognitive and moral shallowness. When it comes to reading, superficial processing, such as scanning and skimming (Mangen, 2008), refers to the gradual shift that digital readers are experiencing towards higher reading frequency of short-length texts and fast-paced content, which do not tend to foster engagement or deep processing (Baron, 2021; Ra et al., 2018). In addition, digital readers are highly exposed to non-professionally created content written by laypersons, with the subsequent risk of encountering fragmented, decontextualized, and even inaccurate information (Bråten et al., 2018). Accordingly, one could argue that exposure to such low-quality text material may not prepare readers to fully engage in deep comprehension processes. Lastly, the type of language that is usually used in digital texts may not follow vocabulary and grammar rules. Contrary to the well-established positive association between print reading and reading comprehension, characteristics of the vocabulary presented in digital texts, which are closer to the oral language than the written one (Snow, 2010), could not display such positive relationship. For instance, social media, online messaging, or blogs, often have conversational traits and are written in informal language. Therefore, digital text readers may not be exposed to the academic vocabulary and high-level grammar structures found in traditional printed texts.

On the other hand, there is evidence suggesting a potential positive relationship between digital reading habits and comprehension. Some studies evidenced positive associations

between digital reading frequency and reading comprehension in adolescents (Botello-Peñaloza & López-Alba, 2014; Duncan et al., 2016; Islam et al., 2020; Jackson et al., 2011; Johnson, 2013; Kong et al., 2022; Wu & Peng, 2017) as well as in college students (Amiama-Espaillet & Mayor-Ruiz, 2017; Chen & Fang, 2013; Mežek, 2013). This could be partially explained because digital reading presents exclusive features that we cannot encounter in print materials, such as interactivity, nonlinearity, immediacy in accessing information, and the convergence of text, images, audio, and video (Chen & Chen, 2014). Interactive features of digital devices, such as questions with feedback, digital glossaries, and collaborative tools, could benefit reading comprehension performance, as a recent meta-analysis developed by Clinton-Lisell et al. (2023) has shown ($g = .66$). Moreover, readers usually find the opportunity to search inside and across different materials beneficial (Baron et al., 2017). Digital reading is often more practical, which is why readers tend to access digital materials to pursue a goal (e.g., gaining more information about a topic, checking for timetables, recipes, etc.; Stadtler et al., 2013), which can potentially increase reading motivation and engagement (Assor et al., 2002). Furthermore, online reading also encompasses communication and social functions (emails, instant messaging, social media) and allows social and collaborative reading (Leu et al., 2011).

Previous literature has analyzed reading comprehension and reading habits across different populations, for example, participants of different ages or educational stages. Looking at specific individual differences could help to clarify the existing differences in the literature on the relationship between digital reading habits and reading comprehension.

2.1.3. Individual characteristics and the development of reading comprehension

Readers' age is one of the most salient factors in the literature analyzing the relationship between reading habits and text comprehension. Most studies have focused on print reading

habits. Through several longitudinal studies, it has been evidenced that such a relationship is not constant and may change across the lifespan. During secondary school, the relationship between reading habits and reading comprehension becomes more relevant, but it weakens as students grow older, reaching a stable level in adulthood. The longitudinal study by Locher and Pfof (2020) showed a medium-sized correlation between leisure reading habits and reading comprehension for students attending secondary school ($\beta = 0.20$; average age = 14.67), that is, a sample from fifth to ninth grade. The correlations decreased with age ($\beta = -0.04$, in the college cohort; average age = 24.77) and reached a stable low level in adulthood ($\beta = 0.07$; average age = 50.74). In a different longitudinal study, van Bergen et al. (2020) analyzed data from 200 Finnish children, followed from age 5 to age 15. Path analyses showed that children's print reading habits and reading comprehension were bidirectionally related. During the early primary school years (second and third grade), the effects run from reading comprehension to print reading habits ($r = .28$), but not the other way around ($r = .12$, not significant). The effect of accumulated—but not recent—practice only emerged in adolescence ($r = .38$). Indeed, this significant relation comes from Grades 3 to 9, but not from Grades 7 to 9. Torppa et al. (2020) reported similar findings from a longitudinal study that followed a sample of 2,525 Finnish students, from age 7 to 16. In Grades 1 to 3, better reading comprehension and fluency predicted more frequent leisure reading, while in later grades (Grades 6 to 9) more leisure reading, particularly of books, predicted higher reading comprehension growth. When it comes to digital reading habits, recent cross-sectional studies emphasize the differences between age cohorts. Salmerón et al. (2023), analyzed National Assessment of Educational Progress (NAEP) data from 2017 (NAEP, n.d.), and found stronger negative relationships between the frequency of use of digital devices in the classroom and reading comprehension in fourth grade, compared to eighth grade (unstandardized estimates = -4.03 vs. -2.07).

In sum, there is no clear pattern for the relationship between leisure digital reading habits and the development of reading comprehension. Apart from individual differences, the readers' social and cultural context could also shape the effects of reading habits on reading comprehension, as we review next.

2.1.4. Technological context and digital readers' habits

Recent years have seen enormous technological advancements, and with these changes has come a transformation in people's reading habits. Social media, a key element in new reading forms, was gradually introduced during the mid-2000s. Similarly, tablets were only available from 2010 onwards. With these changes, reading habits have also undergone changes, transitioning from more traditional formats (print) to more modern ones (digital devices). In principle, as long as readers continue reading, one could expect no major change in the relationship between reading habits and comprehension across years. According to the Displacement Hypothesis (Neuman, 1988), this is because time previously devoted to print reading may just be replaced by time devoted to digital reading. However, from the perspective of the Shallowing Hypothesis (Annisette & Lafreniere, 2017; Carr, 2010), we can expect that the relationship between digital reading habits and comprehension diminishes across years. As social media consumption grows, people have less time for more productive forms of digital reading. Consequently, the time spent reading digital texts may not be as beneficial as it was in previous years. Empirical evidence for this assumption comes from the meta-analysis from Delgado et al. (2018) regarding the differences between digital and print reading on text comprehension. Authors regressed the effect size of that comparison, coded so that positive values indicated a higher difference in favor of print, on the year of publication of the original studies, ranging from 2000 to 2017. Results revealed a small significant positive effect, indicating that, over the years, the difference in favor of print was growing, but not diminishing,

as one could have expected if the effect was due to lack of practice with digital tools in early studies. Authors interpreted this pattern as evidence of a growing negative effect of current digital reading practices, highly associated with quick interactions with short texts. Therefore, the moment in which a study takes place allows us to locate the individual in a given time period, providing us with information about the current social situation, and helps us to identify potential generational characteristics and differences.

2.1.5. The current study

To the best of our knowledge, our study is the first meta-analysis to analyze the relationship between leisure digital reading habits and reading comprehension. Related meta-analyses, already discussed above, have explored the relationship between print reading habits (Mol & Bus, 2011) or reading media (Clinton, 2019; Delgado et al., 2018; Furenes et al., 2021; Kong et al., 2018) on comprehension. The inconsistency across existing literature when it comes to the relation between digital reading habits and comprehension has led us to carry out this meta-analytic study. With this explorative meta-analysis, we aim to determine the relationship between digital reading habits and reading comprehension, evidenced by empirical research conducted during the last 2 decades. The research objectives of this work are:

1. To determine the most prevalent association between leisure digital reading habits and reading comprehension. According to the Displacement Hypothesis, we could expect a positive association between digital reading and reading comprehension, as students may just be replacing the time previously devoted to print reading to digital reading. On the contrary, based on the Shallowing Hypothesis we could expect negative to null effect sizes, due to the frequent low linguistic quality, short-length, and fast-paced content of digital texts.

2. To identify potential moderator variables for the relationship between leisure digital reading habits and reading comprehension, including age, year of data collection, and type of digital reading habits. Based on the reviewed literature of individual characteristics and the development of reading comprehension, we were unable to specify a clear pattern. Accordingly, we test the effect of age and educational stage as an exploratory research goal. In addition, we hypothesize that more recent studies will present a more negative association between leisure digital reading habits and reading comprehension. Lastly, we expect that the relationship between digital reading habits and reading comprehension will be stronger for linear-informative digital reading habits, compared to social-communicative ones.

2.2. Method

In this section, the search procedure, selection, and codification of the included studies are described.

2.2.1. Search

We conducted an initial systematic search using several techniques. The first one corresponded to looking through four academic databases: Web of Science, Scopus, Psych Info, and Eric. Web of Science, Psych Info, and Eric databases also contain gray literature such as dissertations. We entered the following search equation: (“Reading frequency” OR “leisure reading” OR “reading activity” OR “Reading habits” OR “digital habits” OR “print reading” OR “print exposure” OR “social media use” OR “ICT use” OR “internet use”) AND (“text comprehension” OR “Reading comprehension” OR “Reading capacity” OR “reading skills” OR “Reading abilities” OR “literacy level”). The publication years were restricted from 2000 to 2022. These terms were searched as title, abstract, or keywords. We added a second specific search for studies that had worked with PISA or Progress in International Reading Literacy

Study (PIRLS) databases with the search equation: (“PISA” OR “PIRLS”) AND (“computer” OR “digital” OR “online”) AND (“reading”).

As recommended by Card (2012), we complemented the search with additional strategies. Therefore, in a second phase, we examined references included in previous reviews (three eligible studies were found in these reviews but, they were already identified in the initial search). Next, we approached experts and societies in this area (the Society for Text and Discourse, the European Association for Learning and Instruction, and the American Educational Research Association) asking for information about unpublished studies. Additionally, a forward search was performed using Google Scholar to find studies that cited the selected works. Finally, references from the selected studies were also retrieved. The search ended in January 2022.

To filter the search results, we selected those studies that met the following inclusion criteria:

1. It is a scientific study in which digital reading habits and reading comprehension are measured with no intervention (e.g., as an example of excluded work, in the study of Mak et al., 2019, the aim was to analyze the effect of a gamified tool on leisure reading habits).
2. Reading comprehension is evaluated in an objective way, with standardized (e.g., Petko et al. [2017] who used PISA 2012 data) or ad-hoc tests, that is, those created by the researchers for their study purposes. As an example of an excluded work, in the study of Bann et al. (2006) participants self-reported their reading comprehension level.
3. The reading habits assessed referred to leisure time and required reading from some digital device, not only watching (TV) or playing (video games) on them. As an example of an excluded work, Jackson et al. (2011) analyzed the relations between general Internet use, video game playing, and cell phone use on reading skills.

4. The study makes an empirical contribution that includes the results of the comparison (i.e., the paper is not a review or an opinion).
5. The study was published or presented between 2000 and 2022. Formal publication is not required.
6. The report is written in English or Spanish.
7. The report includes specification of the effect size or sufficient statistical information to calculate it (or this information is provided by the authors following a personal request).

The search described above yielded 1,866 records. Following the criteria exposed, 26 studies were considered to perform the effect size calculus, including data from 469,564 individuals. A flow diagram based on PRISMA guidelines (Page et al., 2021) outlines this process in Figure 2.1.

2.2.2. Coding the studies

The first author and an independent research assistant coded all the reviewed articles selected randomly. Inter-rater reliability was adequate, showing a Cohen's kappa equal to .73 ($minimum_{Sampling} = .49$, $maximum_{Assessment\ RC} = .97$) for qualitative variables. Because the Kappa coefficient tends to be low, even though there may be high agreement rates (Warrens, 2010), we also report the mean percentage of inter-rater agreement = 88.90% ($minimum = 77.50\%$; $maximum = 97.40\%$). For continuous variables, the intra-class correlation (95% CI) mean was .96 ($minimum_{Data\ collection\ year} = .89$, $maximum_{Mean\ age} = 1$). Disagreements were discussed. For transparency and objectivity, a coding manual was developed and is available in Appendix A (Supplemental material A1). A descriptive overview of the studies included is given in the Results section. Next, the variables coded across the studies are described.

Regarding substantive variables, we considered average age; percentage of females, and the corresponding educational stage for the participants at the moment the study was conducted. Educational stages were coded following the U.S. system to provide a homogeneous categorization (1 = Elementary school, from first to fifth grade; 2 = Middle school, from sixth to eighth grades; 3 = High school, from ninth to 12th grades; 4 = Undergraduate students, higher education at university levels). To analyze methodological aspects, we included the following variables: total sample size and sampling procedure (0 = non-probabilistic: convenient sampling vs. 1 = probabilistic: random sample selection). Regarding the characteristics of the digital reading habits measurement, we coded the type of data collection instrument (in which 0 = Self-report, refers to self-reported measurements such as filling out a questionnaire or survey and 1 = Interview, refers to in-person interviews in which a third person gathered the information). Due to the variability among the reading habits questionnaires used in the primary studies, we coded the next variables regarding the questions and answers format (examples of these categories are provided in Table 2.1): temporal range (what period of time is being asked, 0 = Non-specified, 1 = Daily habits, 2 = Weekly habits, 3 = Mixed); answer format of the reading habits questionnaire (0 = open vs. 1 = closed); temporal classification of answers (0 = Hours, 1 = Frequency adverbs, 2 = Times per day/week/month, 3 = Mixed), number of answer-alternatives in the scale. Finally, to analyze the potential influence of the type of digital reading habits, we categorized the studies according to the items employed to assess habits. This moderator was labeled as “digital reading habits categories” and items were categorized as 0 = Social-communicative reading (e.g., “Emails, online messages, social networks, blogs”; “Browsing the internet for fun, read or write emails to friends, write a blog or website, chatting online, participate in online forums, participate in social networks ”); 1 = Linear-informative reading (e.g., “E-fiction, e-news, blogs and Bulletin Board Systems”; “e-books, online newspapers, websites on different topics, blog postings, and

forums”); and 2 = Mixed (when the proportion of items from categories 0 and 1 was equivalent or not clear, e.g., “Factual website or blog, online searching, text messages/emails, networking website, computer/console game, and Twitter”; “Electronic reading resources”). Addressing the differences across reading comprehension tests, we coded some variables regarding their characteristics: the media in which participants took the test (0 = Print, 1 = Digital-based); type of assessment (0 = Multiple choice questions, 1 = Open-ended questions, 2 = CLOZE type, 3 = Mixed); type of reading comprehension dimension assessed (0 = Inferential, 1 = Literal, 2 = Mixed); and genre of the text or texts used (0 = Narrative, 1 = Expository, 2 = Mixed). Finally, regarding the reliability of the instruments employed, we considered the reliability coefficients of the reading comprehension test and the reading habits questionnaire. Lastly, we coded two extrinsic variables: the data collection year (when the study was conducted) and the publication status (whether the report was published or not).

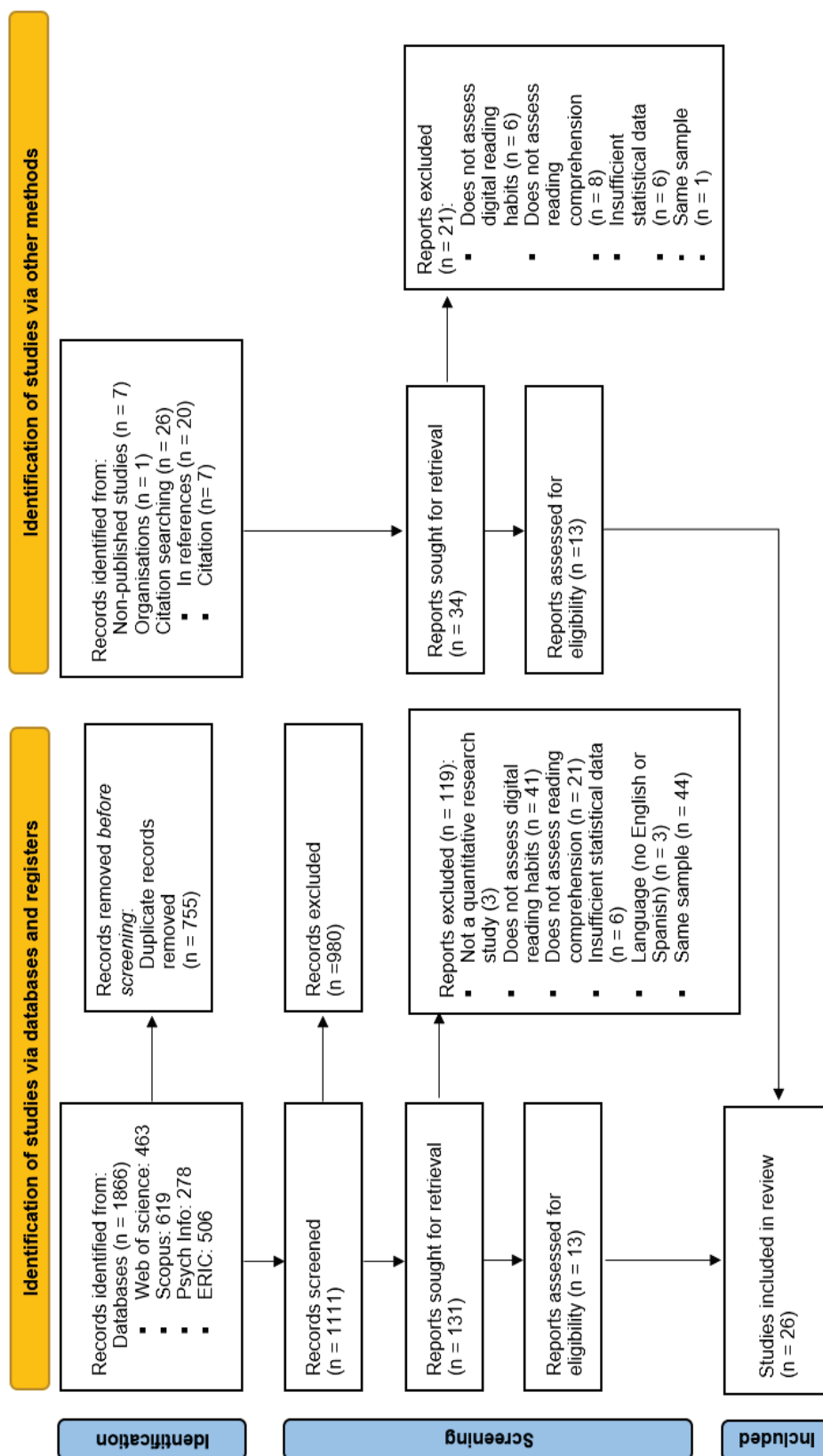
2.2.3. *Effect size calculation*

The effect size used to measure the relationship between leisure digital reading habits and reading comprehension scores was the Pearson correlation coefficient (r) performing multilevel random-effects analysis. If the coefficients were calculated for each item of the reading habit questionnaire separately, we performed an average score by merging this information into one variable (“digital reading habits”).

If the study did not include these correlational analyses, we used two strategies to perform the calculation. First, we tried to use the descriptive data that allowed us to calculate the effect size: mean, standard deviations and sample size for both variables (e.g., the score in reading comprehension according to each reading frequency option).

Figure 2.1

PRISMA 2020 Flow diagram for new systematic reviews which included searches of databases, registers, and other sources.



Note. The selection for studies with the same sample was based on the criteria explained in the Effect size calculation section.

Second, when none of these data were reported, we looked for multiple regression analysis. In this specific case, we could impute the effect size using the following formula:

$$r = \beta + .05 \lambda$$

This formula can be applied only when beta is standardized and when the value is inside a range of - 0.5 to + 0.5. The λ variable is an indicator that equals 1 when β is nonnegative and 0 when β is negative. This procedure was developed by Peterson and Brown (2005) who proposed and evidenced an appropriate approach for imputing r-based meta-analytic effect sizes in behavioral studies using knowledge of corresponding beta coefficients. Ultimately, if any of these strategies could not be carried out, or necessary information was missing to perform other imputation strategies, we wrote to the authors asking for data. To maintain the effect size independence across different studies, we followed specific selection criteria to identify the reports that best fitted our objectives and, additionally, covered a wider population range. Some pre-selected studies worked with the same database. Mostly, this was the case of PISA and PIRLS databases (PISA, n.d., PIRLS, n.d.). Therefore, to carry out the selection, the following criteria were applied, in order of relevance (a comparison table is available in Appendix A, Table A1):

- 1) Digital reading habits. We prioritized those studies that included more items that referred to digital reading habits. This criterion was applied mostly in the selection of PISA studies, as different authors included different items from the same sample.
- 2) Sample size. We prioritized those studies that included a larger sample (usually from different countries). In the case of PISA studies, we discarded the studies that used information from a limited number of countries and which were already addressed in other broader studies. For example, a study using information from 10 countries would be more relevant than one using four.

Table 2.1

Descriptive characteristics of the digital reading habits of the studies included

Study	N of items	Items	Scale	Category
Altamura (2019)	4	Emails, online messages (e.g., WhatsApp), social networks, blogs	5-point Likert scale (Never, Few days per month, Once a week, Few days per week, Every day) - Times per day/week/month	Social-communicative use of reading
Amiama-Espallat & Mayor-Ruiz (2017)	10	Download files, books, fanfiction, magazines or blogs, video, email, consult, virtual platform, virtual shopping, social networks	5-point Likert scale (from 1: Never to 5: Always) - Frequency adverbs	Linear-informational reading
Champley et al. (2008)	1	Electronic reading resources	5-point Likert scale (1: Never to 5: Often) - Frequency adverbs	Linear-informational reading
Chen & Fang (2013)	4	E-fiction, e-news, blogs and Bulletin Board Systems	4-point scale (from 0: Never to 3: Frequently) - Frequency adverbs	Linear-informational reading
Duncan et al. (2016)	6	Factual website or blog (e.g., Wikipedia), online searching, text messages/e-mails, networking website (e.g., Facebook), computer/console game, and Twitter	5-point Likert scale (1: Didn't read this, 2: 30 min or less, 3: 1 hr, 4: 2 hr, 5: 3 hr or more) - Hours (weekly)	Mixed or unspecified
García (2013)	5	Browsing the internet for fun (e.g. YouTube), read or write emails to friends, write a blog or website, chatting online (e.g., Messenger), participate in online forums, participate in social networks (e.g., Twitter, Facebook)	5-point Likert scale (Almost every day, Once or twice a week, A few times a month, Once or twice a month, to Never) - Times per day/week/month	Social-communicative use of reading
Gumus & Atalmis (2011)	6	Browse the Internet for information about people, things, or ideas, Play games, Use the Internet to collaborate with a group or team, Download software from the Internet (including games), Download music from the Internet, For communication (e.g., Email or "chat rooms")	5-point Likert scale (Almost every day, Once or twice a week, A few times a month, Once or twice a month, to Never) - Times per day/week/month	Mixed or unspecified
Heesbeen (2021)	1	"How often do you read digital texts after schooltime, for pleasure or personal interests (e.g., blogs, e-mail, or messages in social media)?"	4-point-Likert scale 1 ('Almost never') to 4 ('almost every day') - Times per day/week/month	Mixed or unspecified
Hsu et al. (2019)	4	Reading e-books, reading on computer, reading on smartphones, texting friends	5-point Likert scale (1: None, 2: <2h, 3: 2-3h, 4: 3-5h, 5: >5h) - Hours (daily)	Linear-informational reading
Johnson (2013)	3	Email, play games, and visit websites	4-point Likert scale (Every day or almost every day, Once or twice a week, Once or twice a month, to Never or hardly ever) - Times per day/week/month	Mixed or unspecified

Table 2.1 (continued)

Study	N of items	Items	Scale	Category
Kanninen et al. (2022)	5	e-books, online newspapers (examples of Finnish online newspapers), websites on different topics (e.g., interests, hobbies, sports), blog postings, and forums (e.g., discussions of games, artists, hobbies)	5-point Likert scale (Hardly ever; 1–2 times per month, 1–2 times per week, Almost every day, Every day) - Times per day/week/month	Linear-informational reading
Kong et al. (2022)	6	Reading emails, reading online news, chatting online, online information searches to learn about a particular topic, participating in online group discussions, and searching for practical information online	5-point Likert scale (Every day, almost every day, once or twice a week, once or twice a month, to never or hardly ever) - Times per day/week/month	Mixed or unspecified
Macedo-Rouet et al. (2019)	2	Communication with family or friends through social networks (Facebook, Twitter ...), looking for information on the Internet about subjects of personal interest (sport, leisure, music, general culture, etc.)	5-point Likert scale (Never or I don't know what it is, Never or hardly ever, About once a month, Once or twice a week, Almost every day, At least once a day, Several times a day) - Times per day/week/month	Mixed or unspecified
Mcgeown et al. (2016)	5	Online searching/web browsing, text messages, emails, social networking site (e.g., Facebook) and Twitter	5-point Likert scale (Don't read this, Less than 1 hour, About 1–2 hours, About 3–4 hours and 5 hours or more) – Hours (weekly)	Social-communicative use of reading
Mežek (2013)	1	“In an average week in term time, how much time do you spend on leisure reading from the Internet sources you mentioned?”	5-point Likert scale (Less than 3.5 hours (30 min a day), 3.5–7 hours, 8–14 hours, 15–21 hours, More than 21 hours) – Hours (daily)	Mixed or unspecified
Norris (2010)	4	Email, chat, surf, video games	4-point Likert scale (Less than once a week, about once a week, several times a week, and every day or almost every day) - Times per day/week/month	Social-communicative use of reading
Park & Weng (2020)	12	PISA 2012 ENTUSE items + Playing online games via social networks (e.g., <Farmville@>, <The Sims Social>), Downloading new apps on a mobile device	5-point Likert scale (Every day, almost every day, once or twice a week, once or twice a month, to never or hardly ever) - Times per day/week/month	Mixed or unspecified
Petko et al. (2017)	10	PISA 2012 ENTUSE items: Playing one-player games; Playing collaborative online games; Using email; <Chatting online> (e.g., <MSN@>); Participating in social networks (e.g., <Facebook>, <MySpace>); Browsing the Internet for fun (such as watching videos, e.g., <YouTube™>); Reading news on the Internet (e.g., current affairs); Obtaining practical information from the Internet (e.g., locations, dates of events); Downloading music, films, games or software from the Internet; Uploading your own created contents for sharing (e.g., music, poetry, videos, computer programs)	5-point Likert scale (Every day, almost every day, once or twice a week, once or twice a month, to never or hardly ever) - Times per day/week/month	Mixed or unspecified

Table 2.1 (continued)

Study	N of items	Items	Scale	Category
Pfost et al. (2013)	3	E-mails; online encyclopedias (e.g., Wikipedia); and online forums or chats	4-point Likert scale (Almost never or never, several times a month, several times a week, several times a day) - Times per day/week/month	Mixed or unspecified
Salmerón et al. (2011)	4	Browsing the internet for fun (e.g., YouTube), read or write emails to friends, write a blog or website, chatting online (e.g., Messenger), participate in social networks (e.g., Twitter, Facebook)	5-point Likert scale (Almost every day, once or twice a week, a few times a month, once or twice a month, to never) - Times per day/week/month	Social-communicative use of reading
Salmerón et al. (2018)	6	Browsing the internet for fun (e.g., YouTube), read or write emails to friends, write a blog or website, chatting online (e.g., Messenger), participate in online forums, participate in social networks (e.g., Twitter, Facebook)	5-point Likert scale (Almost every day, once or twice a week, a few times a month, once or twice a month, to never) - Times per day/week/month	Social-communicative use of reading
Salmerón et al. (2020)	8	Digital novels, digital newspapers, digital books about subjects of personal interests	5-point Likert scale (Every day, few times a week, once a week, few times a month, never) - Times per day/week/month	Linear-informational reading
Smith & Smith (2010)	3	Send or receive e-mail, find information on the internet, talk in Internet-chat groups	5-point Likert scale (Every day, few times a week, once a week, few times a month, never) - Times per day/week/month	Social-communicative use of reading
Torppa et al. (2020)	4	E-mails, messages and Internet conversations, Facebook, and blogs	5-point Likert scale (from Never to Daily) - Times per day/week/month	Social-communicative use of reading
Vergara et al. (2021)	1	Reading on digital devices	Open: weekly hours	Linear-informational reading
Wu & Peng (2017)	6	E-mail, chatting online, online news, searching for a particular topic, searching for practical information, and using online dictionaries or Wikis	5-point Likert scale (from 1: I don't know what it is, to 5: Several times a day) - Times per day/week/month	Social-communicative use of reading

- 3) Sample independence. We prioritized those studies that worked with more independent samples (e.g., data from different countries or age-groups). Regarding longitudinal studies, which included data from the same participants across several years, we decided to take the cross-sectional information from the 1st year in which participants were assessed. In this way, we guaranteed no dragging effect.

2.2.4. Statistical Analyses

Pearson correlation coefficients were transformed into the Fisher's Z metric to normalize distributions and stabilize variances. To facilitate the interpretation of the results, they were transformed back into correlation coefficients. A three level random-effect meta-analysis was applied to address the fact that some effect sizes were nested within studies. This model suits our data best because several of the primary studies analyzed contained information from independent sub-samples (Cheung, 2019). Instead of aggregating the information for each sub-sample, with this multilevel analysis we were able to work with individual effect sizes while controlling dependence at the study-level, increasing statistical power as well (Harrer et al., 2021). In this model, the first level represents a within-effect size model, the second level shows variation between the effect sizes within the same study, and the third one represents variation across studies (van den Noortgate et al., 2013). Despite the fact that the participant level only contributed to one effect size (the sampling errors are conditionally independent), the non-independence could be introduced to the nested structure of the effect size. With the three-level random-effect analysis we could analyze the between-study heterogeneity that would be undetected in aggregated data. We opted for this approach, instead of nesting studies from the same research teams, because variation of sample characteristics and instruments used tended to be more diverse across studies than across teams. Thus, we calculated cluster-robust standard errors, statistical tests, and confidence intervals for our estimates by using the "CR2" method (Tipton & Pustejovsky, 2015). The method used to estimate the model parameters was restricted maximum-likelihood

(REML). The inverse variance method was used to weigh each effect size. An average effect size and a 95% CI were calculated. Furthermore, outliers' cases were assessed with standardized deleted residuals larger than 1.96 (Viechtbauer, 2021; Viechtbauer & Cheung, 2010).

Cochran's Q statistic was used to assess the presence of heterogeneity. The multilevel I^2 statistic was also considered to estimate the proportion of the variance in observed outcomes that reflects variation in true effect sizes rather than sampling error, with $I^2_{\text{Level 2}}$ and $I^2_{\text{Level 3}}$ representing within- and between-study heterogeneity, respectively. Moreover, a 95% prediction interval around the main effect size was calculated to know how the true effect varied across populations (Borenstein, 2019; Cheung, 2014). To explore heterogeneity, the analyses of moderator variables were performed by using multilevel meta-regression models with robust variance estimation method for continuous and categorical moderators. Sensitivity analyses were carried out to assess the robustness of the results. First, the average effect size was calculated for the whole sample of studies and for the sample without the outlier (Gumus & Atalmis, 2011). Second, we ran the same meta-regression analysis for the moderators including the outlier. Third, due to the big variability of sample sizes, the average effect size was compared between those studies which presented extra-large sample sizes and the rest of the studies. Publication bias was assessed using Egger's linear regression (Card, 2012) and applying multilevel meta-regression models to evaluate whether publication status moderated the effect size.

The statistical analyses were performed using the R 4.2.1 version with Metafor (Viechtbauer, 2010) and clubSandwich (Pustejovsky, 2020) packages.

2.3. Results

2.3.1. Descriptive characteristics of the studies

Twenty-six studies fulfilled the selection criteria. Because six of these studies contained independent subsamples, we could analyze a total of 40 independent effect sizes with 469,564 participants. The main characteristics of the studies are described in Table 2.2. With regard to sociodemographic

Table 2.2*Descriptive characteristics of the studies included in the analysis*

Study	Extrinsic Data			Sociodemographic Data			Reading Comprehension Assessment			
	<i>r</i>	<i>N</i>	Published	Data Coll. Year	Mean age (<i>SD</i>)	% Fem.	Student Level	Name of the Test	Genre of the Text(s)	Type of Questions and Assessment
Altamura (2019) Study 1	-.266	35	No: Raw data from	2019	12.11 (0.53)	57.10	Middle school	PROLEC-SE-R (Cuetos et al., 2016)	Expository	Mixed: inferential and literal 10 Multiple-choice questions and 10 open-ended questions
Altamura (2019) Study 2	.055	47	bachelor	2019	13.42 (0.87)	53.20	Middle school			
Altamura (2019) Study 3	-.098	187	thesis	2019	14.16 (0.68)	49.70	High school			
Altamura (2019) Study 4	.027	168		2019	15.03 (0.61)	46.40	High school			
Altamura (2019) Study 5	-.202	119		2019	10.46 (0.553)	42.00	Primary school	PROLEC-R (Cuetos et al., 2014)	Expository and narrative	Inferential 16 open-ended questions
Altamura (2019) Study 6	-.219	85		2019	11.62 (0.38)	44.70	Middle school			
Amiama-Espallat & Mayor-Ruiz (2017)	.253	382	Yes: Research paper	NR	15.15 (0.85)	59.00	High school	Adapted: Based on PISA Texts	Descriptive, expository, argumentative, exposition and diagram	Mixed: location, integration and evaluation 13 multiple-choice questions, six open-ended and three double-entry tables
Champley et al. (2008)	.220	96	Yes: Research paper	2004	72.5 (4.19)	73.90	No students	Qualitative Reading Inventory-3 (Leslie & Caldwell, 2001)	Narrative, expository	Mixed: explicit and implicit
Chen & Fang (2013)	.120	352	Yes: Research paper	2011	NR	59.20	Undergraduates	Reading Comprehension Test developed by Chen and Su (2010)	NR	Mixed: literal (e.g., lexical access and parsing) and inferential (e.g., integration, summarization and analogy) comprehension
Duncan et al. (2016) Study 1	.063	201	Yes: Research paper	2009	12.66 (0.89)	57.80	Middle school	YARC Secondary test (Stothard et al., 2010)	Fiction and non-fiction	Mixed: Vocabulary, literal, or inferential. 12 questions
Duncan et al. (2016) Study 2	-.041	99		2009	15.09 (0.53)	50.50	High school			
García (2013) Study 1	.192	23	No: Doctoral thesis	2013	11.5	47.36	Middle school	TPC (Martínez et al., 2008)	Expository	Mixed: explicit ideas (literal) comprehension, inference making between different paragraphs ideas, and between texts ideas and readers' prior knowledge 20 multiple-choice questions
García (2013) Study 2	.054	142		2012	11.6	51.00	Middle school			
Gumus & Atalimis (2011)	.425	4,942	Yes: Research paper	2006	15.9	46.30	High school	2006 PISA Reading assessment (OECD, 2006)	Narrative, expository, descriptive, argumentative/persuasive, instructive	Mixed: retrieve information, interpret information, reflect on text content, reflect on the structure of the text Multiple-choice, short closed-constructed response, and open-(extended) constructed response
Heesbeen (2021)	.060	108	No: Doctoral thesis	2021	11.1 (0.7)	47.20	NA	Cito Reading Comprehension test (CITO; Centraal Instituut voor Toetsontwikkeling; Institute for Test Development Netherlands, 2016).	Fictional story and formal text	Mixed: fill in the blank, prediction of content, text content, searching in sources, and summarizing Multiple choice questions
Hsu et al. (2019)	-.127	50	Yes: Research paper	2019	22.88 (4.71)	52.00	Undergraduates	Gray Silent Reading Test - GSRT (Wiederholt & Blalock, 2000)	Narrative	NR five multiple-choice questions
Johnson (2013)	.207	90	Yes: Research paper	NR	10.63 (1.3)	34.50	NA	Adapted from the Wide Range Achievement Test Sentence Comprehension subtest (Wilkinson & Robertson, 2006)	NR	NR Cloze technique

Table 2.2 (continued)

Study	Extrinsic Data		Sociodemographic Data				Reading Comprehension Assessment			
	<i>r</i>	<i>N</i>	Published	Data Coll. Year	Mean age (<i>SD</i>)	% Fem.	Student Level	Name of the Test	Genre of the Text(s)	Type of Questions and Assessment
Kannianinen et al. (2022)	.090	426	Yes: Research paper	2014	12.34 (0.33)	47.00	Middle school	ORCA (Caccia et al., 2019) – Online assessment	Expository	Mixed: locating information, evaluating information, synthesizing information, and communicating information. Process and open tasks
Kong et al. (2022)	.130	14,087	Yes: Research paper	2018	15	49.10	High school	Digital reading comprehension 2018 PISA Assessment (OECD, 2019)	Descriptive, narrative, expository, argumentative, instructive, transaction texts	Mixed: scanning and locating, literal comprehension, inferential comprehension, assessing quality and credibility, reflecting on content and form, searching for and selecting relevant text, multiple-text inferential comprehension, corroborating/handling conflict Multiple choice and open constructed-response
Macedo-Rouet et al. (2019)	-.005	146	Yes: Research paper	2018	14.73 (0.53)	53.40	High school	Protocole Emilie (Duchêne May Carle, 2010)	Narrative	NR True/false
McGeown et al. (2016)	-.082	784	Yes: Research paper	2012	9.91 (0.88)	52.70	Primary school	Macmillan Test Unit, Group Reading Test II (2000)	NR	NR Cloze technique
Mežek (2013)	.075	31	Yes: Research paper	2009	NA	85.30	Undergraduates	SweSAT-R (2006)	NR	NR Four multiple-choice questions
Norris (2010)	.059	515	No: Doctoral thesis	2004	11.25 (6.34)	54.00	NA	Peabody Individual Achievement Test (PIAT Comprehension) (Dunn & Markwardt, 1970)	NR	NR
Park & Weng (2020)	-.016	168,098	Yes: Research paper	2015	15.78	NR	High school	2015 PISA Reading assessment (OECD, 2017)	Narrative, expository, descriptive, argumentative/persuasive, instructive	Mixed: retrieve information, interpret information, reflect on text content, reflect on the structure of the text. Multiple-choice, short closed-constructed response, and open- (extended) constructed response.
Petko et al. (2017)	.078	222,811	Yes: Research paper	2012	15.77 (0.048)	NR	High school	2012 PISA Reading assessment (OECD, 2013)	Narrative and expository	High inferences 26 multiple-choice
Pfost et al. (2013)	-.117	1,124	Yes: Research paper	2010	13.4	52.70	Middle school	NA	Expository	Mixed: retrieve information, interpret information, reflect on text content, reflect on the structure of the text 17 multiple-choice questions and three open-ended
Salmerón et al. (2011) Study 1	-.093	74	No: Unpublished raw data	2011	12.36 (0.538)	51.90	Middle school	Weblec (Salmerón et al., 2018) and ComplEC (Llorens et al., 2011) (we used the ComplEC scores)		
Salmerón et al. (2011) Study 2	.141	58		2011	13.49 (0.658)	51.90	Middle school			
Salmerón et al. (2011) Study 3	-.029	77		2011	14.48 (0.749)	44.90	High school			
Salmerón et al. (2011) Study 4	.236	64		2011	15.48 (0.651)	41.50	High school			
Salmerón et al. (2018) Study 1	-.209	138	Yes: Research paper	2015	12.13 (0.542)	41.50	Middle school			
Salmerón et al. (2018) Study 2	-.137	132		2015	13.17 (0.601)	45.90	Middle school			
Salmerón et al. (2018) Study 3	.068	136		2015	14.18 (0.651)	50.00	High school			
Salmerón et al. (2018) Study 4	.007	136		2015	15.13 (0.579)	47.80	High school			

Table 2.2 (continued)

Study	Extrinsic Data		Sociodemographic Data				Reading Comprehension Assessment			
	<i>r</i>	<i>N</i>	Published	Data Coll. Year	Mean age (<i>SD</i>)	% Fem.	Student Level	Name of the Test	Genre of the Text(s)	Type of Questions and Assessment
Salmerón et al. (2020) Study 1	.118	191	No: Unpublished	2020	20.95 (3.959)	86.90	Undergraduates	CLOZE (Salmerón et al., 2022)	Narrative	High inference from little context Cloze technique (34 items)
Salmerón et al. (2020) Study 2	.063	120	raw data	2020	22.76 (5.593)	80.70	Undergraduates			
Smith & Smith (2010)	.311	17,668	Yes: Research paper	2003	NA	57.10	Mix	NAAL literacy assessment (NAAL; NCES, n.d.a)	Prose literacy. Prose texts can be further broken down as expository, narrative, procedural, or persuasive. Document and quantitative literacy	NR
Torppa et al. (2020)	-.060	1,813	Yes: Research paper	2013	12.5	NA	Middle school	YKÄ (Lerikkanen et al., 2018)	NR	NR
Vergara et al. (2021)	.045	113	No: Unpublished raw data	2021	20.02 (1.88)	92.00	Undergraduates	CLOZE (Salmerón et al., 2022)	Narrative	High inference from little context Cloze technique (34 items)
Wu & Peng (2017)	.122	33,696	Yes: Research paper	2009	15.77	50.78	High school	Printed Reading Assessment (PRA), Digital Reading Assessment (DRA) from 2009 PISA tests (OECD, 2010) (we used the PRA scores)	Narrative, expository, descriptive, argumentative/persuasive, injunctive	Mixed: retrieve information, interpret information, reflect on text content, reflect on the structure of the text Multiple-choice, short closed-constructed response, and open-(extended) constructed response

Note. *r* = effect size, *N* = number of participants, Data Coll. Year = Data Collection Year, % Fem = percentage of female participants, NA = not applicable, NR = not reported.

variables, the average age was 15.9 years (range = 9.9–72.5) and the mean percentage of female participants was 54.84% (range = 41.5–92.0). The majority of participants were middle school (35.89%) and high school (35.89%) students. Regarding the methodological variables, 66.67% of effect sizes were from studies that recruited the sample through a nonprobability sampling method. The most common data extraction method for measuring digital reading habits was the questionnaire (97.37%) with restricted questions (97.7%), as only one study did not use questionnaires and only one measured the reading habits frequency with open answer format, these variables were not included in the moderator analysis. On average, reliability of the reading comprehension tests used (Cronbach $\alpha = .77$) was higher than that of the digital reading habit questionnaires ($\alpha = .59$). Finally, in the case of extrinsic variables, 56.41% of effect sizes were from published research.

2.3.2. *The mean effect size*

To start, an exploratory analysis was conducted in order to assess influential cases and normality assumption before analyzing the average effect size. A particular effect size was identified as an influential outlier (Gumus & Atalmis, 2011; standardized deleted residuals larger than 3.42), and accordingly it was not used to estimate the average correlation. Therefore, the analyses presented include 39 effect sizes.

The overall association between leisure digital reading habits and reading comprehension was significant and positive, although the effect was rather small ($r = .055$; 95% CI [.003, .107]; $p = .03$; $k = 39$, $n = 25$). Therefore, on average, people that engage in more frequent leisure digital reading activities tend to score higher in reading comprehension tasks. In reference to the variability of the effect sizes, the heterogeneity Q statistic reached statistical significance, $Q(38) = 2591.93$, $p < .001$. The I^2 statistic was 98.9, that is, 98.9 of the variance in the observed effects reflected variance in true effects rather than sampling error. The majority of true variance comes from between-study variance (68.5%), versus within-study variance (30.5%). Furthermore, the prediction interval was -.18 to .29.

This range is usually wider than the confidence interval, particularly when there is great heterogeneity in the data (Al Amer & Lin, 2021), as is the case in our meta-analysis. We would expect that the true effect size of all comparable populations would fall in this range in 95% of all populations.

2.3.3. Analyzing moderator variables

The heterogeneity found led to an analysis of the influence of potential moderator variables. Tables 2.3 and 2.4 show the results of applying multilevel metaregression analyses with robust variance estimation to assess the influence of moderator variables on the effect sizes for qualitative and quantitative moderators, respectively. With regard to the sociodemographic variables, educational stage was a significant moderator ($p = .047$; $R^2 = .57$). We performed pairwise comparisons across the levels and two comparisons were significant: the difference between middle and high school students ($p = .021$) and between primary and university students ($p = .030$). The results showed that the effect size for high school students was positive and higher ($r = .085$) than the effect size obtained in middle school students ($r = -.025$). In addition, the mean age of the participants exhibited a positive relationship with the effect sizes, although this difference was not statistically significant ($p = .175$). As most of the samples included student populations (97.40%), we decided to narrow down the selection. In this regard, we carried out a second analysis in which we included studies whose participants were students, excluding only two reports (Champley et al., 2008; Smith & Smith; 2010). The regression analysis turned out to be statistically significant only when including primary and secondary school students ($p = .03$; $R^2 = .38$) and revealed higher effect sizes as the mean age of the students increased ($\beta = .012$). Finally, the percentage of female participants did not reach a statistically significant relationship with the effect sizes ($p = .181$; $R^2 = .00$).

Table 2.3

Results of the mixed-effects meta-regressions for the qualitative moderator variables on the effect sizes obtained from the studies

Variable	<i>k</i>	<i>n</i>	<i>b</i>	SE	95% C.I. [LL, UL]	<i>F</i> (df)	<i>Q_E</i> (df)	<i>Pseudo</i> <i>R</i> ²	<i>p</i>
<i>Sociodemographic variables</i>									
Educational stage	36	22				13.522 (3, 2.44)	1238.47 (32)***	.57	.047
Primary/ Elementary ¹	2		-.095	.018	[-.32, .13]				
Middle school ²	14		-.025	.035	[-.10, .06]				
High school ²	14		.085	.026	[.01, .03]				
Undergraduate ¹	6		.070	.03	[-.03, .17]				
<i>Methodological variables</i>									
Extra-large sample size	39	25				2.976 (2, 8.72)	2554.687 (37)***	.12	.153
< 10.000	34		.029	.029	[-.02, .08]				
>10.000	5		.127	.056	[-.02, .28]				
Sampling method	35	22				.0851 (1, 17.52)	2573.99 (33)***	.00	.774
Non-probability	26		.06	.037	[-.01, .13]				
Probability	9		.08	.041	[.003, .15]				
<i>Digital reading habits instrument characteristics</i>									
Temporal ranges	38	34				1.919 (4, 5.43)	1540.57 (34)***	.27	.204
Non-specified	5		.11	.07	[-.09, .30]				
Daily	4		.21	.07	[-.06, .48]				
Weekly habits	5		.00	.04	[-.11, .12]				
Mixed	24		.03	.03	[-.05, .07]				
Temporal classification	38	24				.1791 (2, 5.04)	2578.79 (35)***	.00	.841
Hours	5		.03	.064	[-.20, .26]				
Frequency adverbs	5		.09	.074	[-.12, .31]				
Times per day/week/month	28		.05	.031	[-.02, .12]				

Table 2.3 (continued)

Variable	<i>k</i>	<i>n</i>	<i>b</i>	SE	95% C.I. [LL, UL]	<i>F</i> (df)	<i>Q_E</i> (df)	<i>Pseudo</i> <i>R</i> ²	<i>p</i>
Number of answer alternatives	38	24				.1305 (2, 1.66)	2577.87 (35)***	.00	.886
4-point Likert-scale	4		.02	.058	[-.16, .21]				
5-point Likert-scale	32		.05	.031	[-0.006, .12]				
7-point Likert-scale	2		.09	.107	[.03, .26]				
Type of digital reading habit	39	25				1.499 (2, 13.35)	1740.73 (36)***	.02	.258
Social-communicative	21		.03	.048	[-.08, .14]				
Linear-informative	8		.12	.037	[.02, .21]				
Mixed	10		.03	.033	[-.04, .11]				
<i>Reading comprehension test characteristics</i>									
Media	32	18				.0684 (1, 8.84)	1373.97 (30)***	.00	.799
Printed	25		.07	.041	[-.02, .16]				
Digital-based	7		.05	.031	[-.03, .14]				
Text genre	34	20				.3701 (2, 5.06)	2545.36 (31)***	.00	.708
Narrative	5		.02	.042	[-.12, .16]				
Expository	15		.06	.04	[-.04, .16]				
Mixed	14		.08	.05	[-.02, .18]				
Assessment method	35	21				.4867 (3, 4.83)	1341.74 (31)***	.00	.707
Multiple-choice questions (MCQ)	8		.01	.049	[-.10, .14]				
Open-ended	6		.05	.011	[-.27, .39]				
CLOZE type	4		.01	.060	[-.25, .28]				
Mixed	17		.09	.034	[.008, .17]				
Reading comprehension dimension	31	17				5.169 (1, 3.35)	1241.34 (29)***	.44	.098
Inferential	6		-.05	.058	[-.24, .14]				
Literal	0								
Mixed	25		.08	.022	[.03, .13]				

Table 2.3 (continued)

Variable	<i>k</i>	<i>n</i>	<i>b</i>	SE	95% C.I. [LL, UL]	<i>F</i> (df)	<i>Q_E</i> (df)	<i>Pseudo</i> <i>R</i> ²	<i>p</i>
<i>Extrinsic variables</i>									
Published status	39	25				.4312 (1, 10.38)	2588.62 (37)***	.00	.528
Non-published	17		.03		[-.05, .12]				
Published	22		.06		[-.005, .13]				

Note. *k*: number of effect sizes. *n*: number of studies (clusters). *r*: mean effect size. *F*: statistical test for testing the significance of the moderator variable. *Q_E*: statistic for testing the model misspecification. *pseudo R*²: proportion of variance explained by the moderator (τ^2 between - τ^2 within) ^{1,2} Significant paired comparisons. **p* < .05. ***p* < .01. ****p* < .001.

Regarding the methodological variables, the multilevel analysis did not identify any variable as a significant predictor. Contrary to our expectations, no differences were observed regarding the type of digital reading habit and reading comprehension (*p* = .18): social-communicative habits (*r* = .03), linear-informative habits (*r* = .12). Regarding the extrinsic variables, differences were not found in the magnitude of the effect sizes in regard to published status (*p* = .53; *R*² = .00). This was also confirmed by the publication bias analysis (see the sensitivity section). Lastly, contrary to our expectations, the data collection year was not significant as a predictor (*p* = .121).

2.3.4. Sensitivity and bias analysis

For the sensitivity analysis, we calculated the average effect size for the studies, including the outlier (see Table 2.5). When comparing the calculations without the outlier, we observe that the average value is slightly higher and also significant. The main difference is found in between-cluster variance, being almost half when removing the outlier. In this case, σ^2 is equivalent to the between-study heterogeneity variance (τ^2) in a conventional meta-analysis (since clusters represent studies in our model).

Second, we performed multilevel meta-regression analysis for moderator variables including

Table 2.4

Results of the mixed-effects meta-regressions for the continuous moderator variables on the effect sizes obtained from the studies

Variable	<i>k</i>	<i>n</i>	<i>b</i>	<i>SE</i>	95% <i>C.I.</i>	<i>F(df)</i>	<i>Q_{E(df)}</i>	<i>R</i> ²	<i>p</i>
<i>Sociodemographic variables</i>									
Mean age of student sample	34	21	.012	.001	[-.01,.03]	2.32 (1,6.44)	1293.22 (32)***	.38	.175
Mean age of student sample from Primary and Secondary school	30	18	.028	.011	[.002, .05]	6.04 (1, 9.12)	1289.91 (28)***	.36	.036
Percentage of female	35	21	.003	.002	[-.002, .01]	2.53 (1, 4.35)	533.53 (33)***	.00	.181
Percentage of male	34	21	-.003	.002	[-.01, .002]	2.54 (1, 4.30)	538.48 (32)***	.00	.181
<i>Methodological variables</i>									
Sample size	39	25	.00	.00	[-.00, .00]	. ²	2298.81 (37)***	.00	.965
Reading comprehension test reliability	35	21	.326	.265	[-.29, .95]	1.51 (1, 7.35)	1020.92 (33)***	.31	.257
Digital reading questionnaire reliability	30	17	-.012	.140	[-.36, .34]	.007 (1, 5.57)	240.41 (28)***	.13	.935
Number of items (DRH)	39	25	.00	.01	[-.02, .02]	0.001 (1, 6.21)	874.86 (37)***	.00	.969
<i>Extrinsic variables</i>									
Collection data year	38	24	-.01	.006	[-.02, .003]	2.978 (1, 8.43)	826.69 (36)***	.34	.121

Note. *k* = number of effect sizes. *n* = number of studies. *b* = unstandardized regression coefficient. 95% CI [LL, UL]. *F* = statistical test for testing the significance of the moderator variable. *Q_E* = statistic for testing the model misspecification. *Pseudo R*² = proportion of variance explained by the moderator (τ^2 between - τ^2 within). ² Not statistical power enough to load the calculus. **p* < .05. ***p* < .01. ****p* < .001.

the outlier. The significance of the moderators remained the same except for the data collection year which turned out to be significant ($b_{with\ outlier} = -.014$; 95% CI [-.27, -.001]; *p* = .043). In order to assess

whether publication bias might be a threat against our metaanalytic results, two techniques were applied. The Egger test of the intercept did not reach a statistically significant result ($b = -.039$; 95% CI $[-1.39, .61]$; $p = .427$).

Table 2.5

Results of the mixed-effects meta-regression analysis for the average effect sizes obtained from the studies

Analysis	r	95% C.I. [LL, UL]	p	95% P.I. [LL, UL]	τ^2 between	τ^2 within
Main Analysis	0.073	[.012, .013]	.019	[-.21, .35]	.014	.004
Infl. Cases Removed ¹	0.055	[.003, .107]	.039	[-.18, .29]	.009	.004

Note: r : mean effect size, τ^2 between: between-study variance, τ^2 within: within-study variance.

¹Removed as outliers: Gumus & Atalmis (2011).

In addition, multilevel meta-regression analyses with robust variance estimation revealed that the mean effect sizes from published versus unpublished studies were not statistically different ($p = .525$). Thus, these results suggested that there was no publication bias. Lastly, five studies were categorized as having extra-large samples ($N > 10,000$): Kong et al., (2022), Park & Weng (2020), Petko et al., (2017), Smith & Smith (2010), and Wu & Peng (2017). This criterion was followed based on a recent between studies with extra-large samples and the rest of studies ($p = .153$). This means that the relationship between digital reading habits and reading comprehension from studies with small and large sample sizes are not statistically different.

2.4. Discussion

This meta-analysis sought to shed light on the inconclusive relationship between leisure digital reading habits and reading comprehension and to identify potential moderator variables for such relationship. By conducting multilevel analysis, this work provides robust information controlling for intra-studies

dependencies. Still, we found great heterogeneity among studies, calling for a cautious interpretation of the data.

Regarding our main objective, the results evidenced a positive and significant association between digital reading habits and reading comprehension. The effect size is rather small, especially when compared with previous meta-analytical studies that have evidenced medium to strong positive associations between print reading habits and comprehension (Mol & Bus, 2011). Regarding moderator analysis, students' academic stage played a significant role on the association between reading comprehension and digital reading habits: the relation is negative in younger populations (i.e., primary and middle school students), and becomes positive in older populations (i.e., secondary school and undergraduate students). All in all, these results allow us to untangle the relationship between reading habits and reading comprehension when it comes to the digital context, revealing that leisure digital reading habits do not pay off as much as traditional print reading.

Why is the relationship between reading habits and reading comprehension so different when it comes to different media? At this point, we can only speculate about those divergent patterns. Our results do not support the predictions from the displacement hypothesis, as the current change from print to digital reading habits dramatically decreased the association between habits and reading comprehension. Accordingly, we cannot just assume that the societal move towards digital reading habits mobilizes and spurs the same comprehension resources as previously reported for print reading habits. An alternative explanation could rely on the Shallowing Hypothesis (Annisette & Lafreniere, 2017; Carr, 2010), which emphasizes that the superficial way in which people tend to interact with new forms of digital reading may not support readers' engagement or further development of higher-order cognitive skills. The frequent characteristics of digital reading texts, such as short length and fast-paced stimuli, emphasize shallow processing (Baron, 2021; Ra et al., 2018). Additionally, the lower linguistic quality of digital texts may prevent students from being exposed to academic models

typically found in traditional printed texts (Snow, 2010). Future research should continue exploring these issues.

2.4.1. Digital reading habits and the development of reading comprehension

Our analysis contributes to the ongoing debate on the influence of digital technologies on the development of reading comprehension (Wolf, 2018). Previous longitudinal research regarding the relationship between reading habits and comprehension has already highlighted how such a relationship can vary across the life span (Locher & Pfof, 2020; Torppa et al., 2020; van Bergen et al., 2020). Nevertheless, there is still no clear developmental pattern for this relationship. Our exploratory analysis indicated a significant negative relationship between leisure digital reading habits and reading comprehension at earlier educational stages—such as primary and middle school, compared to high school— in which the relationship turned out to be positive, as was the case with undergraduate students. This pattern concurs with recent evidence showing a stronger negative association between the frequency of use of digital devices in the classroom and reading comprehension in representative samples of fourth grade in the United States, as compared to eighth grade (Salmerón et al., 2023). Nevertheless, due to the correlational nature of the original studies analyzed, we can only speculate about the underlying reasons for those differences. Such results could be interpreted in light of potential early sensitive developmental periods. Great exposition to digital reading activities, which frequently contain low linguistic quality texts, may detract early readers from building a strong reading foundational base. For example, early readers engaging in frequent digital reading may learn less academic vocabulary and syntax (Snow, 2010), or develop to a lesser extent the ability to keep focused on a task (Koolstra et al., 1997), in a critical period when they are shifting from learning to read to reading to learn. Future research should test those and other potential causal mechanisms for developmental variations in the association between digital reading habits and reading comprehension.

Beyond the developmental aspects, we expected that the type of digital reading habits would contribute differently to reading comprehension (Naumann & Sälzer, 2017). Our moderator analysis regarding this factor did not reach statistical significance, a pattern that does not align with previous research showing larger effect sizes for linear-informative digital reading habits than for social-communicative ones (Duncan et al., 2016; McGeown et al., 2016; Pfof et al., 2013). Future research may clarify the nature of those effects by analyzing the combined relation between types of digital reading habits and print reading ones, in light of the Displacement Hypothesis. Combining digital linear-informative reading habits with print reading habits may be particularly beneficial. In the same line, research is needed to identify how different types of digital reading habits influence comprehension across the life span. This type of research would disentangle the cause of the negative associations between digital reading habits and reading comprehension observed for younger students, which may potentially be restricted to social-communicative habits.

2.4.2. Limitations and future research

There are some limitations in this meta-analysis that should be discussed. Three relevant limitations are related to the existing datasets. First, we found several studies that belonged to the same research teams, which may add unexpected bias to the results. As explained in the method section, we tried to control as much as possible the dependency effects between each effect size by using a multilevel approach that controlled for the level of student, sub-sample, and study. As this research field continues to expand, future analyses would be able to include primary studies from a larger range of teams. Second, most of the primary studies used a cross-sectional design, so we relied on correlational coefficients that cannot inform us about causal effects. A larger number of longitudinal studies is needed in order to provide accurate estimates about causal relations between habits and comprehension. Third, most of the primary studies measured reading habits via self-reports with closed-answer options; thus, the information could be biased and tied to human-measurement errors.

Moreover, we only included leisure digital reading habits. Therefore, research focusing on other reading purposes, like academic reading, or exploring digital and print reading habits in combination, would be relevant for this matter. In addition, the scope of the search was narrowed down to assessments in readers' native language and did not include studies that were focused on readers with learning difficulties or physical impairments. From the perspective of the Matthew effects on reading, one could expect that the relationship between digital reading habits and reading comprehension may be smaller or even negative in students with learning difficulties. Future research could clarify this issue by carrying out studies focusing on this type of reader. Referring to our dependent variable, the studies included in this meta-analysis focused on traditional text reading comprehension (i.e., linear texts). Future research should explore the associations between digital reading habits and digital reading comprehension (i.e., hypertext, Internet documents). Finally, from a methodological perspective, we highlight that the nature of our data is aggregated, meaning that we have worked with means which do not reflect individual differences inside the studies. In addition, pseudo R^2 coefficient used in multilevel meta-regression analysis cannot be considered fully stable when the number of introduced studies is below 40 (van den Noortgate et al., 2013). For this reason, we recommend taking the proportion of explained variance with caution.

As for the difficulties encountered, we highlight the heterogeneity of the scales and instruments used across studies, both regarding digital reading habits and reading comprehension measurements. Creating a standardized scale to assess digital reading habits may help to set a common ground for new studies. However, given the evolving nature of the tasks offered by new digital tools and services, such a scale may be difficult to create. That is why, when proposing future investigations, research in this field could benefit from using methods such as questionnaires to address common reading habits and, additionally, exploring qualitative dimensions such as the length of reading, motivation, and attitudes towards reading (Kaye et al., 2020). Moreover, triangulation with other data collection techniques should include more objective measures (such as phone use time-trackers or observational

techniques), as a recent systematic review has evidenced that the correspondence between self-reported and logged social media use is far from perfect (Parry et al., 2021).

2.5. Conclusion

While the use of digital devices in education is an undeniable reality nowadays, our results emphasize the need to increase the awareness of how students interact with them and how this relates to important educational factors such as text comprehension. Based on our results, we cannot just assume that leisure reading time would be beneficial for developing readers, regardless of the medium used. The notable difference between the effect sizes of previous meta-analysis regarding print reading habits and the present work leads us to search for further explanations. Based on our moderator analysis, we cautiously recommend educators and practitioners to pay more attention to how different digital reading habits can play a role in the reading comprehension of younger readers. Because the heterogeneity found across effect sizes is rather big, we consider this meta-analysis only as a first step into exploring the relationship between reading comprehension and digital reading habits.

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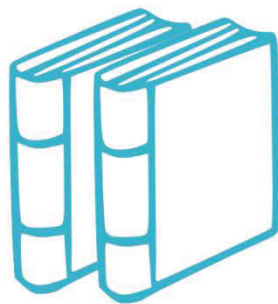
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Chapter III



Study 2

Validation of the Multidimensional Reading Habits Instrument for primary school students

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Chapter III

Study 2 - Validation of the Multidimensional Reading Habits Instrument for primary school students

3.1. Introduction

In the past, reading literacy has been defined as the process of extracting and constructing meaning from written texts (Snow, 2002). The current information landscape, characterised by vast amounts of easily accessible information through different media, has reshaped the ways and tasks people perform when interacting with texts. Accordingly, new definitions of reading literacy have been proposed to accommodate the new sets of skills needed to successfully participate in education and society nowadays (OECD, 2019a). Specifically, the 2018 PISA reading framework defines reading literacy as “understanding, using, evaluating, reflecting on and engaging with texts in order to achieve one’s goals, to develop one’s knowledge and potential and to participate in society” (OECD, 2019a, p. 28). A critical task for literacy researchers is to examine the factors that contribute to adequate development of such new competence of reading literacy during primary school, by paying attention to both individual as well as contextual factors (Butterfuss et al., 2020; Cain & Barnes, 2017).

Here, we focus on a particularly relevant factor: students' reading habits, defined as the frequency of independent engagement in different reading activities (McGeown et al., 2015). Reading habits may support comprehension development via repeated reading practice and exposure to increasingly complex linguistic information (Allington & McGill-Franzen, 2021; Stanovich & Cunningham, 1992). The present study aims to elaborate and validate an instrument that provides further insight into nowadays reading habits in young students, differentiating between the reading purpose (leisure or academic) and the reading media (print or digital) in which

reading takes place. As part of the sources of validity evidence, we will examine the relationship of the different reading habits dimensions to reading comprehension and motivational factors.

3.1.1. Characteristics of reading habits in Primary school: context, purpose and reading media

During their development, students' reading habits can vary according to multiple factors, such as context, purposes, or media (Clark & Teravainen-Goff, 2020; Willingham, 2017). First, an essential factor is the context where reading takes place. To refer to those reading habits that students engage inside the school, researchers usually use the term *in-school reading*. Conversely, autonomous reading, outside formal educational contexts, is known as *out-of-school reading* (Anderson et al., 1988; OECD, 2019a). Secondly, reading can be defined, at the same time, by the student's purpose (Wood et al., 2022), either due to an inner joyful drive (i.e. leisure reading) or by the need to complete school tasks, such as studying for a test or doing classwork or homework (i.e., academic reading) (Lupo et al., 2017; McKenna et al., 2012). In the literature, free-time, pleasure reading has been referred as "leisure reading" (e.g., Jabbar & Warraich, 2023; Torppa et al., 2020; Willingham, 2017), but also "enjoyment reading" (e.g., Wang & Guthrie, 2004) and "extracurricular reading" (e.g., Pfof et al., 2013). All these terms describe the type of reading engagement in which there is no explicit instruction or perceived obligation to do so (McKenna et al., 2012). In contrast, academic reading is part of the school's instruction, so students read to fulfil some educational goal (i.e., homework or study) (Wang & Guthrie, 2004). Lastly, the reading media is a relevant factor in reading habits as nowadays students not only read in printed materials. The proliferation of digital reading devices, coupled with widespread access to such technologies and the diversity of reading materials like e-books, social media platforms, and digital newspapers, has introduced new reading habits in the population (OECD, 2019b). National data suggests that the computer is one of the most used digital devices among Spanish children (INE, 2023). Reports from 500.000 children between 10 and 12 years-old indicate that computer usage is high, with 89.5% of 10-year-olds,

92.5% of 11-year-olds, and 93.9% of 12-year-olds using a computer. In contrast, mobile phone ownership is notably lower among younger children, with 23.3% of 10-year-olds, 45.7% of 11-year-olds, and 65.0% of 12-year-olds owning a mobile phone. Survey studies suggest that the surge in digital device accessibility could be displacing the traditional practice of reading printed books (Merga & Roni, 2017).

Previous literature has focused on reading attitudes of middle and high-school students, making the distinction of reading purpose (recreational-academic) and reading media (print-digital) (McKenna et al., 2012; Lupo et al., 2017). In these studies, the focus was on the affective dimension of reading. However, less is known about the extent to which primary school students engage in reading habits (behavioural dimension of reading attitudes), depending on the reading purpose, in combination with their reading media. Thus, this is still an open question that could be further addressed with an appropriate instrument. Because we identify some individual restrictions regarding in-school reading, such as school rules about personal digital usage (e.g., Selwyn & Bulfin, 2016) or in-class low variability due to teachers' management (e.g., McKenna et al., 2012), in the current study we present an instrument designed to examine out-of-school reading habits. As we shall review next, research has identified two main factors related to several out-of-school reading habits that will represent the basis of our validation process: reading comprehension and reading motivation.

3.1.2. Associations of reading habits with reading comprehension and reading motivation

3.1.2.1. Reading habits and reading comprehension

A large body of literature has evidenced positive longitudinal associations between reading habits and reading comprehension in a wide range of ages and countries (Allington & McGill-Franzen, 2021; Mol & Bus, 2011; Sparks et al., 2014; van Bergen et al., 2018, 2020). This relationship has been proved to be bidirectional, meaning that higher reading abilities also promote reading

frequency; such mutual relationship has been labeled as the "virtuous circle of reading" (Pfof et al., 2013), and has been replicated by affective attitudinal research (Lupo et al., 2017). Importantly, the evidence that supports this virtuous circle is based mostly on leisure print-reading habits. Less is known about newer reading habits in young students, like digital reading, or reading for other purposes, such as for school-related tasks. Recently, the meta-analysis by Altamura et al. (2025) suggested that the virtuous circle of reading is not replicated when it comes to leisure digital reading habits. The average effect size, based on the data from 25 studies (39 effect sizes) was 0.055, representing practically a null relationship between reading comprehension and leisure digital reading habits. Moreover, this "not-so-virtuous circle" seems to be different depending on the reader's educational stage. At early stages (primary and middle school) negative relationships were observed between leisure digital reading and reading comprehension ($\beta = -0.095$ and $\beta = -0.025$, respectively), while at later stages (high school and university) the relationship was positive ($\beta = 0.085$ and $\beta = 0.075$). Although the causal mechanisms for this phenomenon are still unknown, a potential reason is that older students possess a broader knowledge base and employ more advanced self-regulation strategies, which may help them to develop methods to reduce the shallow processing and distractions associated with on-screen reading (Salmerón et al., 2023).

The small correlation between digital reading and reading comprehension is supported by studies focusing on the affective dimension of reading attitudes. Specifically, Lupo et al. (2017) found no significant correlations between recreational digital text attitudes and reading comprehension from high-school students. Conversely, students demonstrated the most positive attitudes toward this type of text, compared to recreational print and academic (print and digital), matching with the current rising frequencies of digital devices use in young students (Merga & Roni, 2017; OECD, 2019b). Consistent with the scarce literature that has pursued out-of-school academic reading, the meta-analysis from Altamura et al. (2025) did not include academic reading habits. Some studies point towards non-significant positive correlations between academic print

reading and reading comprehension in primary school students (McGeown et al., 2016). Additionally, some studies with adolescents also point towards a null relationship between out-of-school academic digital reading habits and reading comprehension (Petko et al., 2017), while others point to a small negative relationship, either for leisure or academic purposes (Park & Weng, 2020). In this study, we will provide sources of validity evidence regarding the relationship between reading habits and reading comprehension focusing on the behavioural dimension.

3.1.2.2. Reading habits and reading motivation

The pleasure or enjoyment that a reader feels can be partially explained in motivational terms. Extensive research supports the strong association between motivation and reading habits, referred to as reading behaviour in some studies (Schiefele et al., 2012; Soemer & Schiefele, 2018, Troyer et al., 2019). Similarly to the reviewed studies about reading habits and comprehension, this research has focused mainly on leisure print reading. Generally, intrinsic motivation is associated with higher frequency of leisure print reading (Schiefele et al. 2012; Soemer & Schiefele, 2018, Troyer et al., 2019), while extrinsic is negatively associated (Becker et al., 2010; Wang & Guthrie, 2004; Troyer et al., 2019). Few studies have analyzed the role of reading motivation on different reading media habits. McGeown and colleagues (2016) examined the reading habits of 8 to 11 years-old students. The authors replicated previous patterns in which intrinsic motivation positively predicted leisure print reading and evidenced that extrinsic motivation positively predicted leisure digital reading. Additionally, McGeown et al. (2016) included one item that tapped academic reading, in this case the item was limited to print. They found that some indicators of the motivation dimensions, such as school grades (extrinsic) and curiosity (intrinsic), predicted academic reading (McGeown et al., 2016). As far as we know, no other study has addressed the relationship between digital reading habits and reading motivation. While previous behavioural research has provided valuable insights based on their specific objectives, a comprehensive measurement is necessary to

fully capture the multidimensional nature of reading habits. To that endeavor we will review in detail how past research has addressed reading habits measurement.

3.1.3. Reading habits measurement: dimensionality and validity

Reading habits can be measured through different methodologies, each offer advantages and disadvantages that need to be considered by researchers (Locher & Philipp, 2023). Self-questionnaires are the most widely used due to their ease and speed, but their accuracy can be compromised by limited response options and memory bias. More precise methods, such as reading diaries (Locher et al., 2023) and experience sampling (Sonnenberg et al., 2012), demand greater time and effort, and they may alter subsequent reading behaviour. Another common but indirect method is the use of checklists, which include author and title recognition tests. Locher and Philipp (2023) highlight their imprecise measurement and lack of comparability across studies. Digital log-data provides objective measurements (Parry et al., 2021), though cannot track offline activities, like print reading. Lastly, interviews offer rich qualitative data but are time-consuming and not easily generalizable (Rutledge & Hogg, 2020).

From the available methods, self-questionnaires are the most employed to measure reading habits (Altamura et al., 2025; Jabba & Warraich, 2022). For this reason, we will focus on this method. However, their widespread use is not translated into homogeneous instruments. These differences influence the representativeness of the constructs and may lead to inaccurate conclusions across studies. In Table B1 (see Appendix B) we present a summary of the items employed in some studies that have measured children's reading habits for leisure and/or academic purposes and have attempted to distinguish the reading media employed. Following Locher and Philipp (2023) dimensions, we have selected proximal and general studies. Accordingly, we have categorized item information according to the *purpose of reading* (leisure or academic) and *reading media* (print or digital), as suggested by Locher and Philipp (2023) and exemplified by McKenna

et al., (2012) and Lupo et al., (2017). We will describe the common aspects through these studies in terms of content validity, referring to the extent to which a set of items can represent a content domain (DeVellis & Thorpe, 2022), including the specificity (number of items) and representativeness (variety of content). From each study, we will detail the *measurement of reading frequency* (which question, if available, and answers options were presented), and the *psychometric properties* of the items/scales employed (dimensionality and internal consistency, when available). After selecting relevant literature, we categorized the items employed by six local studies (Duncan et al., 2016; Johnson, 2013; Kanninen et al., 2022; McGeown et al., 2016; Pfof et al., 2013; Torppa et al., 2020) and two international assessment scales from PIRLS 2016 and 2021 (Mullis et al., 2017, 2023). This summary will serve as a starting point to our main objective: the elaboration of a comprehensive instrument to measure reading habits.

With regard to the reading purpose, we find a stronger focus on leisure reading habits measurement, presenting higher specificity than academic reading habits. The number of leisure reading items varies from 1 (e.g., PIRLS, 2016, 2021) to 14 (e.g., Duncan et al., 2016). The studies including different types of activities reflect higher representativeness (e.g., Duncan et al., 2016; Kanninen et al., 2022; McGeown et al., 2016; Pfof et al., 2013; Torppa et al., 2020), than those that include only one low-specific activity (e.g., “How much time do you spend reading outside of school on a normal school day?” in PIRLS, 2021). In the case of academic reading habits, the range of items goes from 1 (e.g. Duncan et al., 2016; e-PIRLS, 2016; McGeown et al., 2016) to 5 (e.g., Johnson et al., 2013). Again, there are different degrees of content validity of the academic reading dimension, from broad single items (e.g., “School textbook” in McGeown et al., 2016) to more specific sets of reading activities (e.g., at school: “use the internet, use email, instant messaging, use the internet to play games, visit websites” in Johnson et al., 2013).

Adding to the differences per reading purpose, we also find different item choices depending on the reading media. Usually, for leisure reading habits there are a rather balanced set of items for

print and digital reading in the same study (e.g., Duncan et al., 2016; Kannianen et al., 2022; McGeown et al., 2016; Pfof et al., 2013; Torppa et al., 2020). Regarding digital reading, these items cover different digital reading activities, from static reading (e-book) to internet navigation or social-communication. Conversely, for academic reading habits measurement, studies usually include items that tap exclusively one of the two reading media: print (e.g., Duncan et al., 2016; McGeown et al., 2016) or digital (Johnson et al., 2013; Pfof et al., 2013, PIRLS, 2016, 2021 and e-PIRLS, 2016).

Beyond the specificity and representativeness of the selected items, another important aspect is how reading frequency is measured. We find heterogeneity across the recall intervals prompts and the units of frequency presented in the answers' options. Some of the selected studies use prompts that ask for broad or unspecific periods of time (e.g., "How often/much time do you...?" in Pfof et al., 2013; PIRLS 2016, 2021) while other studies refer to recall intervals with more specific time-frames, whether within a day (PIRLS, 2016, 2021), the previous weekend (Duncan et al., 2016) or an average week (McGeown et al., 2016). This feature is important because asking for specific days may lead to lower representativeness than asking in average terms (Locher & Philipp, 2023; Sonnenberg et al., 2012). With regard to the answers' options, most studies use stylized estimates, precisely, Likert-scales which also vary in the units of reading frequency. Usually, studies that employ broad recall intervals use a combination of times per day, week and month (e.g. Kannianen et al., 2022; Pfof et al., 2013; Torppa et al., 2020). Conversely, studies that use prompts referred to specific days tend to use smaller time units, such as hours spent reading (e.g., Duncan et al., 2016; PIRLS, 2016, 2021; e-PIRLS, 2016).

Lastly, regarding the psychometric properties of the instruments, few studies explore the dimensionality of the scales employed (e.g., Kannianen et al., 2022; Pfof et al., 2013; Torppa et al. 2020). Even though it is recommended to analyze the internal structure or consistency of any assessment instrument's items (American Educational Research Association et al., 2014), not all

the studies have psychometric data available. This can also be due to the purposes of each study, as in some cases they treat all or some items separately (e.g., Duncan et al., 2016).

3.1.4. Research objectives

In sum, research measuring reading habits presents considerable lack of consistency and has not addressed differences depending on the purpose (leisure or academic) and the reading media (print or digital). This study aims to address these gaps by developing and validating an out-of-school reading habits measurement instrument for primary school students. Our research objectives are:

- To describe the current reading habits of Spanish primary school students by presenting descriptive data from the newly developed instrument. Additionally, we will explore the role of gender and grade.
- To assess the sources of validity evidence based on internal structure by evaluating the instrument's dimensionality and internal consistency.
- To examine the sources of validity evidence based on relationships with other variables by investigating how different dimensions of reading habits (leisure-print, leisure-digital, academic-print, academic-digital) relate to students' reading comprehension and motivation.

3.2. Method

3.2.1. Participants

In total, 2,077 students participated in this study. The students were in three school grade levels corresponding to the last years of primary education in Spain: Grade 4, 5 and 6. The minimum age, in fourth grade, is 9 years and the maximum age, in sixth grade, is 12 years. Students belonged to 16 schools, from public to private systems. Data from 94 teachers indicate that digital devices are

used, on average, around 1 or 2 times per month in class for reading comprehension instruction. For more detailed information about sociodemographic information, refer to Table 3.1.

The Research Ethics Commission of the University of Valencia approved the protocol of the study (register # 1894095). APA ethical standards and the guidelines of the Helsinki Protocol were followed in conducting the study. Parents or legal guardians signed an informed consent form.

Table 3.1

Sociodemographic information of participants

	n	%
Grade		
4	716	34.5
5	666	32.1
6	695	33.5
Gender		
Feminine	919	44.2
Masculine	858	41.3
Prefer not to respond	65	3.1
Missing	235	11.3
Type of school		
Public	442	21.3
Private	597	28.7
State-subsidized school	1005	48.4
Compensatory education	33	1.6
School location inhabitants		
< 20.000	5	31.3
20.000 - 30.000	4	25.0
30.000 - 50.000	1	6.3
> 50.000	6	37.4

3.2.2. Instruments

3.2.2.1. Reading habits

We constructed the Multidimensional Reading Habits Instrument (MRHI), an instrument that comprises two questionnaires differentiating the reading purpose (leisure and academic). These two questionnaires contain 8 items each, half of the items ask for reading activities performed in printed materials and the other half ask for digital reading. An English version of the MRHI is available in Appendix B (Supplemental materials B1).

3.2.2.2. Reading comprehension test

We used the *Reading Comprehension Assessment* (ACL) tests (Català et al., 2001), a standardized Spanish reading comprehension test. The corresponding version was used for each grade. These tests present narrative, expository and discontinuous texts (e.g., maps or tables). The questions cover main dimensions of reading comprehension: literal, inferential, and evaluation. Good internal consistency was determined, using a tetrachoric matrix to calculate ordinal omega scores (ω ACL grade 4 = .81, ω ACL grade 5 = .81, ω ACL grade 6 = .82).

3.2.2.3. Reading motivation

We used an expanded version of the Elementary School Motivation Scale (ESMS-E) (Ramos et al., 2022). The items of the intrinsic and external dimensions were taken from this version (Mañá et al., 2023), 3 items for Intrinsic (e.g., “I like reading”) and 3 for Extrinsic (e.g., “I read to please my parents or my teacher”). Students indicated their degree of agreement with generic reading statements on a five-point scale from 1 (strongly disagree) to 5 (strongly agree). Dimension scores were calculated as the average of the corresponding items. Good internal consistency was determined, using a tetrachoric matrix to calculate ordinal omega scores (ω for Intrinsic dimension = .87, ω for Extrinsic dimension = .72).

3.2.3. Procedure

The procedure to create the MRHI was based on the guidelines recommended by Kishore et al. (2021), consisting in four points. (1) To select the most appropriate items for our instrument, we first reviewed previous studies that used reading habits questionnaires tapping purpose and media. This review has been presented in the introduction section and summarized in Table B1 (see Appendix B). (2) We selected the most common items across the reviewed studies and adapted them to fit in a homogeneous structure. We ensured that the number of items was the same in each questionnaire and dimension. Therefore, some items regarding academic reading needed to be created. Regarding the prompt for this reading purpose, we focused solely on teachers' instructions for academic reading (instead of also referring to parents' demands) to maintain consistency with previous studies, ensure a clear distinction between school-related and leisure reading, and to avoid the complexities introduced by diverse family structures, which could lead to measurement inconsistencies. The initial items were based on authentic school experiences in Spain and national statistical data (i.e., prevalence of computers over smartphones, INE, 2023).

Thanks to the combined work of the authors, the opinion of one academic expert on psychometric assessments and two schoolteachers, we finally drafted two questionnaires, one for each reading purpose: leisure and academic reading, with two dimensions each, depending on the reading media: print and digital. For the measurement of reading frequency, we selected a 4-point scale that combines times per day, week and month (0: Every day or almost every day, 1: Once or twice a week, 2: Once or twice a month, 3: Never or hardly ever). This decision was based on methodological studies that have determined that 5-point scales lead to more confusion on young students than 4-point scales, especially when they include “moderate” options (Coombes et al., 2021). (3) To assess the comprehensibility of the items we asked for the collaboration of five young readers and their parents (2 boys and 3 girls between 8 and 11 years old). They answered the proposed questionnaires and were explicitly asked about the comprehensibility and difficulty of the

items. We asked the parents to inform us of any doubt they received from their children during the questionnaire completion. After this qualitative assessment we corrected and corroborated the suitability and comprehensibility of the items. (4) Data collection took place between March-June 2022. In the assessment session students completed first the reading comprehension test, followed by the reading habits questionnaire and motivation scale. All tests were completed individually on printed material, usually in the reference classroom, where there was always, at least, one examiner.

3.2.4. Data analyses

As a first step in the psychometric evaluation, we ran descriptive analysis for the whole sample. For each school grade see Appendix B (Table B2 to B5). We calculated central tendency (mean and standard deviation) and normality (skewness and kurtosis) measures. For the latest, we considered absolute skewness values ≤ 2 or an absolute kurtosis ≤ 4 to reflect considerable normality (Mishra et al., 2019). Secondly, to evaluate the internal structure of the questionnaires and its dimensions we performed two confirmatory factor analysis (CFA) in Mplus 8.11 (Muthén & Muthén, 2017). We employed the Weighted Least Squares Mean (WLSM) for ordered data with cluster by class ($n_{class} = 122$). This strategy provides high robustness to the results by considering the group-level influences on the measured variables (Muthén, 1994). Model fit was assessed using Standardized Root Mean Square Residual (SRMR). This index ranges from 0 to 1, with a lower value indicating better fit or lower residuals. Hu and Bentler (1999) consider that values below .08 indicate a good model fit. As a parsimony-adjusted index we used the Root Mean Square Error of Approximation (RMSEA). It also ranges from 0 to 1, with smaller values being more desirable. Some authors (e.g., Byrne, 2010) suggest the following criteria: 0 = perfect fit, $< .05$ = close fit, $.05-.08$ = adequate fit, $.08-.10$ = mediocre fit, and above $.10$ = inadequate fit. Lastly, as incremental fit index we used the Comparative Fit Index (CFI). Its values range from 0 to 1 with higher values being the most appropriate. Values above .90 are considered acceptable values, and values of .95

indicate a very adequate fit (Hu & Bentler, 1999). Based on the obtained CFA factor loadings of each scale, we calculated composite reliability for each of the four dimensions (leisure print, leisure digital, academic print and academic digital). This is a robust indicator of internal consistency that accounts for the interrelatedness of items within each subscale (Bentler, 2009). The criteria for composite reliability values depend much on the number of items included in the scale, with authors supporting <0.60 when a scale has less than 5 items (Netemeyer, 2003).

Lastly, to establish concurrent validity evidence for the relationship between the proposed reading habits, reading comprehension and motivation we employed Pearson's correlation. To provide information about gender and grade in relation to the measured variables we used Spearman's rank-order correlation coefficient. For these analyses and the descriptives we employed SPSS 26 (IBM Corp, 2019).

3.3. Results

3.3.1. Descriptive results

Table 3.2 reports the main descriptive values for the whole sample and all the items of each questionnaire. Overall, the most frequent activities are those related to academic reading in print. Schoolbooks, worksheets and exercises from the notebooks are read, on average, between *Once or twice a week* and *Every or almost every day*. Fiction books for school are read between *Once or twice a month* and *Once or twice a week*. The second most frequent activity, on average, is leisure digital reading. For example, "reading on the internet about information that it's of interest to the reader" and "to communicate with others" are activities performed, on average, *Once or twice a week*. It contrasts with the lower frequency of leisure digital books (average close to *Never or almost never*). Similar frequencies are reported for academic digital reading. We observe that the use of digital books is also not common, being the least frequent reading activity for academic purposes (average between *Never or almost never* and *Once or twice a week*). However, this does not mean

that students do not use technologies for their schoolwork, as they indicate that, on average, they use the internet “to look for information to do their tasks”, “to better understand some topics” and “to send emails with their classmates and/or teachers” between *Once or twice a month* and *Once or twice a week*. Lastly, children reported leisure print activities as the least frequent reading activities. On the one hand, children claimed to read printed books, both those from topics of interest and fiction books, between *Once or twice a month* and *Once or twice a week*. On the other hand, other types of printed content are not that frequent, e.g. comics and magazines frequencies are close to *Never or almost never*. Regarding the normality of the items, the skewness and kurtosis indexes indicated that the items' answers follow a normal distribution. In Appendix B detailed descriptives differentiating by each grade are provided in Tables B2 to B4. In Table B5 there is also a descriptive table differentiating by gender.

3.3.2. Internal structure

The internal structure of the questionnaires was assessed through two confirmatory factor analyses (CFAs). Both CFAs showed adequate model fit indexes. First, the Leisure reading purposes questionnaire showed the following values: $RMSEA = .052$, 90% CI [.043, .061]; $CFI = .900$; $SRMR = .042$ ($N = 2059$). To obtain a model closer to the reality we indicated the existence of a correlation between items 7 and 8 errors (Internet to communicate and Send emails). The reason was theoretically based, as in the literature these items are presented separately but they convey a close activity: communication.

The overall correlation between the two reading formats dimensions, print and digital, was statistically significant and negatively associated ($r = -.126$, $p = .018$). This means that the more time a student reads for leisure in print the less they report reading on digital media and vice versa. Standardized parameter estimates for this model are shown in Figure 3.1 (a).

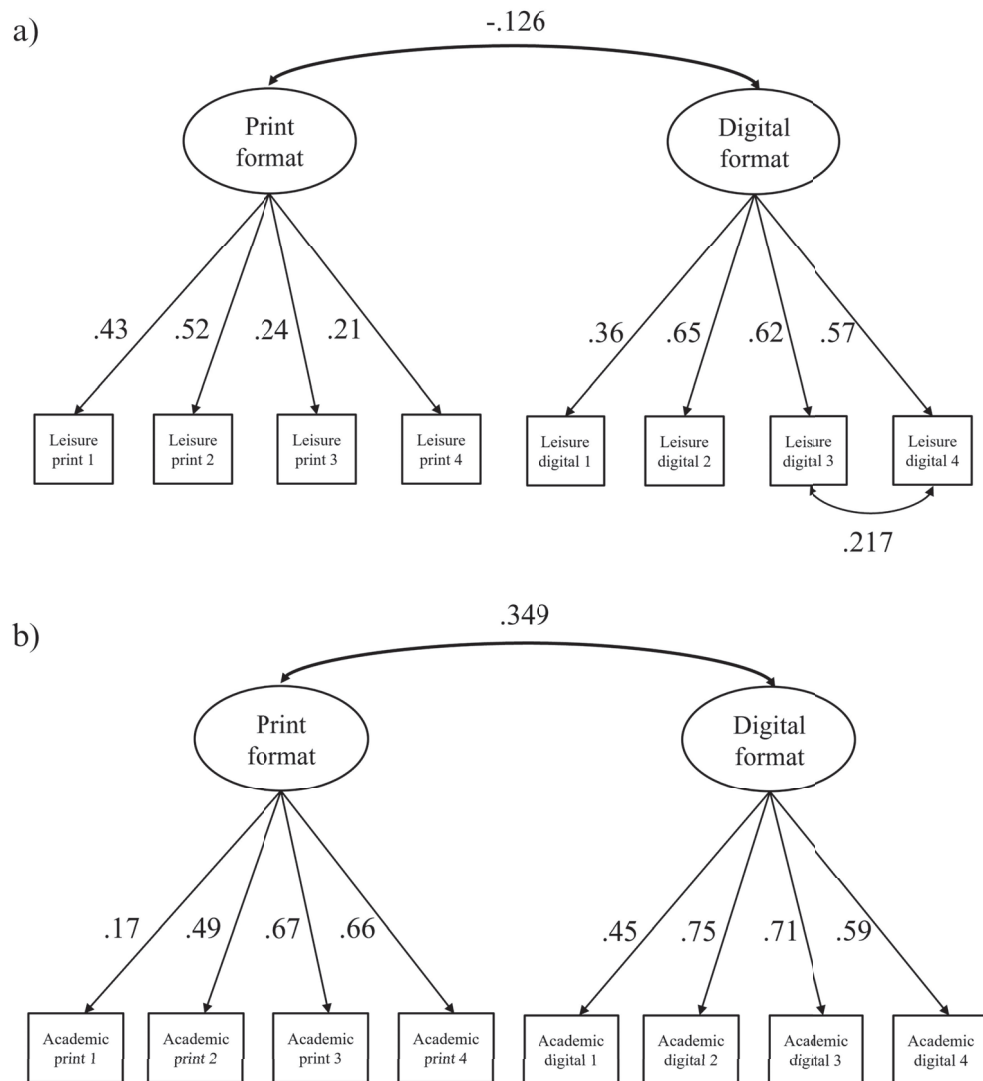
Table 3.2*Descriptive analysis for all items*

	<i>N</i>	<i>Mean</i>	<i>SD</i>	<i>Skewness</i>		<i>Kurtosis</i>	
				<i>Statistic</i>	<i>SE</i>	<i>Statistic</i>	<i>SE</i>
Leisure purposes							
<i>Print (average)</i>	2021	1.07	0.57	0.34	0.05	-0.19	0.11
Specific topics books	2049	1.34	1.04	0.12	0.05	-1.18	0.11
Fiction books	2048	1.58	1.08	-0.09	0.05	-1.26	0.11
Comics and graphic novels	2042	0.97	1.13	0.73	0.05	-0.96	0.11
Magazines	2052	0.41	0.73	1.83	0.05	2.77	0.11
<i>Digital (average)</i>	2032	1.55	0.72	-0.24	0.05	-0.67	0.11
Digital books	2048	0.70	0.98	1.13	0.05	-0.03	0.11
Internet to look for information	2051	2.05	0.97	-0.68	0.05	-0.61	0.11
Internet to communicate	2043	1.95	1.18	-0.67	0.05	-1.11	0.11
Send emails	2047	1.49	1.17	-0.03	0.05	-1.47	0.11
Academic purposes							
<i>Print (average)</i>	2001	2.04	0.58	-0.74	0.05	0.46	0.11
Fiction books	2051	1.44	1.02	-0.01	0.05	-1.12	0.11
Schoolbooks	2041	2.12	0.99	-0.86	0.05	-0.39	0.11
Worksheets	2040	2.11	0.89	-0.75	0.05	-0.25	0.11
Exercises notebook	2029	2.47	0.80	-1.51	0.05	1.62	0.11
<i>Digital (average)</i>	2022	1.35	0.73	0.15	0.05	-0.76	0.11
Digital schoolbooks	2035	0.95	1.07	0.66	0.05	-0.97	0.11
Internet to do homework	2049	1.72	0.97	-0.26	0.05	-0.91	0.11
Internet to understand	2048	1.51	1.02	-0.06	0.05	-1.11	0.11
Class emails	2049	1.20	1.11	0.37	0.05	-1.24	0.11

Note. N is not constant due to missing values in individual items. Reading habits answer-scale: 0) Never or hardly ever, 1) Once or twice a month, 2) Once or twice a week, 3) Every day or almost every day

Figure 3.1

Graphic representation of standardized factor loadings from leisure and academic reading habits questionnaires' confirmatory factor analyses



Note. (a) Leisure reading habits questionnaire, (b) Academic reading habits questionnaire.

Second, appropriate goodness of model fit indexes was obtained for the Academic reading purpose questionnaire: $RMSEA = .023$, 90% $CI [.013, .033]$; $CFI = .986$; $SRMR = .026$ ($N = 2057$). In this case both media dimensions were positively correlated ($r = .349$, $p < .001$), thus if a student reports more time reading for academic purposes in print, they will also report higher frequencies

for academic digital reading. Standardized parameter estimates for this model are shown in Figure 1 (b). All factor loadings were significant in both CFAs.

Based on the factor loadings of each CFA we calculated composite reliability indexes for each dimension. For leisure reading, the composite reliability was .367 for the print dimension and .633 for the digital. In the academic reading questionnaire, the composite reliability was .581 for print and .722 for digital dimension. Considering the acceptable threshold of .60 for composite reliability (Netemeyer et al., 2003), the print dimensions presented poor internal consistency. We will expose in more detail factors influencing reliability values in the discussion.

3.3.3. Evidence of test-criterion validity

As for the evidence of test-criterion validity we present Pearson correlations of the proposed reading habits dimensions with the scores of reading comprehension and reading motivation constructs (Table 3.3). As expected for reading comprehension, we find positive correlations between leisure print reading habits and reading comprehension. This association is not significant in the case of academic print, and it turns out negative in the case of both leisure and academic digital reading habits. In this case, the negative correlation value is higher for academic digital reading than for leisure. Similarly, for the relations with motivation, we find positive relationships between intrinsic motivation and print reading habits, the magnitude of this correlation outstands from the other dimensions, and it contrasts with the small negative relations exhibited with digital reading habits. This pattern is present in both reading purposes, leisure and academic. As for extrinsic motivation, we observe positive correlations with digital reading in both purposes' scales, presenting similar magnitudes. In contrast, extrinsic motivation shows negative small magnitude correlation with leisure print reading habits. We replicated associative patterns found in previous studies, except in the case of academic digital reading habits. We cannot compare our results in this area due to the limited available literature.

Table 3.3

Pearson correlations for aggregated reading habits dimensions of the MRHI, reading comprehension and reading motivation dimensions

	1	2	3	4	5	6	7	8
1. Leisure print								
2. Leisure digital	-.033							
3. Academic print	.183**	.103**						
4. Academic digital	.013	.512**	.215**					
5. Reading comprehension	.148**	-.084**	.044	-.135**				
6. Intrinsic motivation	.540**	-.087**	.183**	-.053*	.225**			
7. Extrinsic motivation	-.052*	.120**	.047*	.150**	-.196**	-.187**		
8. Gender ¹	.103**	-.070**	-.061*	-.094**	-0.012	-.096**	.052*	
9. Grade ¹	-.102**	.253**	.011	.224**	-.134**	-.088**	-.049*	.043

Note. ** $p < .01$, * $p < .05$. ¹ For Gender (0= Girls, 1= Boys) and Grade (0= 4, 1= 5, 2= 6) we employed Spearman's rank-order correlation coefficient.

Additionally, we also explored the relationship of the measured variables with gender and grade. Regarding gender, we observe that, on the one hand, boys engage more in leisure print reading and have slightly higher extrinsic motivation. On the other hand, girls show higher frequencies for academic reading (irrespective of the media), engage in more frequent leisure digital reading, and present slightly higher intrinsic motivation for reading. Regarding grade we determine that higher-grade students engage more frequently in leisure and academic digital reading, but less in leisure print reading. There is no significant correlation between grade and academic print

reading. Lastly, students also tend to present slightly lower reading comprehension, intrinsic motivation, and extrinsic motivation as they advance in grades.

To summarize the various sources of validity evidence reported in this study, we have added this information to Table B6 in Appendix B. This table gathers the findings from previous research along with our own results, based on the proposed criteria. It allows for a clear comparison, highlighting the alignment between our findings and those of previous studies. The robust criteria accomplishment supports the validity of the MRHI.

3.4. Discussion

Considering the heterogeneity in reading habits measurement and the lack of comprehensive instruments for primary school students, this work aimed to cover the need for an adequate measurement, developing and validating the Multidimensional Reading Habits Instrument (MRHI). This instrument was designed based on previous literature that had aimed to measure reading habits but did not address the different purposes and different reading media in which children engage in nowadays. Thus, the MRHI contains two questionnaires differentiating out-of-school reading purposes (leisure and academic) and distinguishes among print and digital reading formats. Acknowledging the new and diverse reading habits is particularly relevant given their different associations with reading comprehension (Altamura et al., 2025; Mol & Bus, 2011).

3.4.1. Reading habits prevalence

Outside school, our data show that students from fourth to sixth grade tend to read more frequently for academic purposes, especially in print. The second most frequent activity is leisure digital reading, followed by academic digital reading, with the lowest frequency for leisure print reading. Our findings show some discrepancies when compared to the results reported in previous studies. For example, previous studies reported the highest frequencies for leisure print reading habits (Kanniainen et al., 2022; McGeown et al., 2016; Torppa et al., 2020). Conversely, Pfof et al. (2013)

reported leisure digital reading as the most frequent activity. This pattern is supported by global assessments trends indicating a decline in leisure print reading and increased digital reading (Clark et al., 2023; Merga & Roni, 2017; OECD, 2019b). In our study, the higher reading frequency of academic print materials, compared to previous studies, could be due to the limited or null representativeness of academic reading habits in past studies. Because the MRHI explicitly addresses the different reading purposes, the answers of young students could be somehow different from those studies that did not present such differentiated items. All children need to read, at least to some extent, to fulfil their academic tasks at home (e.g., homework) (Willingham, 2017). Therefore, it is logical to observe that academic print reading is the most frequent reading activity.

Regarding sociodemographic factors, boys present higher frequencies for leisure print, while girls show higher frequencies in digital. Metaanalytic evidence indicates that, although girls read more for leisure, boys show stronger preferences for print materials (Jabbar & Warraich, 2023). Regarding academic reading, girls showed higher reading frequencies than boys in both print and digital. Previous studies do not show gender differences regarding school-book reading (McGeown et al., 2016; Duncan et al., 2016). Unlike these studies, the MRHI differentiates reading media, therefore we can expect different results from a more precise measurement and better reflections of their media preferences.

As for age, we observe higher frequencies of digital reading as grade increases. This is supported by other studies such as McGeown et al., (2016) in middle-school students and Duncan et al., (2016). Conversely, matching with recent longitudinal studies, leisure print reading frequencies diminish with age (Bittman, 2024). No significant correlations were found between grade and academic print reading, although in previous research this correlation is significant and positive (Duncan et al., 2016; McGweon et al., 2016). We suggest that these age-related changes may be more closely tied to academic digital reading, an area still underexplored in the literature.

3.4.2. Sources of validity evidence

Our work proposes an instrument with two separate questionnaires according to the reading purpose (leisure and academic) which contain the same number of items for print and for digital reading format. This ensures equal specificity for each reading habit dimension. Through different sources of validity evidence, the proposed questionnaires show good validity evidence regarding internal structure and test-criterion relationships with reading comprehension and reading motivation. Regarding their internal structure, both questionnaires present good model fit indexes, suggesting that the hypothesized factor structure is a valid representation of the data and accurately reflects the underlying constructs using cluster-control analysis. To our knowledge, this is the first instrument that combines purpose and reading media and explicitly addresses these dimensions. We assessed internal consistency reliability using a composite reliability index, which accounts for class clustering by incorporating factor loadings from the CFAs. Our reliability values range from .367 to .722, a rather large range which is not uncommon in previous scales measuring reading habits (e.g., Torppa et al., 2020, reported ranges from .46 to .82). For scales with fewer than 5 items, values under .60 indicate insufficient internal consistency (Netemayer, 2003). We propose two main reasons why we found these low reliability values. First, the number of items included per dimension in our questionnaires could promote lower reliability values. As Netemayer (2003) highlights, this index is sensitive to the number of items, being favoured by higher quantities. Balancing item specificity and applicability is crucial, as longer questionnaires can increase internal consistency but also cause fatigue and disengagement (Nunnally & Bernstein, 1994). This is a common issue to all scale developers but is particularly relevant for children assessment, who are more prone to fatigue and disengagement than adults (Christensen & James, 2008). The second reason why we could have obtained low reliability indexes is linked to the type of construct we are addressing. Reading habits are a broad construct that involves various activities, and not all activities may be performed to the same extent by every reader. For example, for leisure print, one

student may prefer reading only comics, while another student may equally enjoy books, magazines, and comics. These differences in reading profiles can lead to a lack of internal consistency as not all items' answers will be homogeneous (Devellis & Thorpe, 2022).

Our second type of validity evidence is based on relationships with other variables, specifically reading comprehension and reading motivation (Schiefele et al., 2012). By examining the correlation between the proposed reading habits and these variables, we obtained reliable criterion-validity evidence. For instance, we obtained positive correlations between leisure print reading habits and reading comprehension, replicating previous findings (Schiefele et al., 2012; Soemer & Schiefele, 2018; Troyer et al., 2019) and null for academic print reading habits as in McGeown et al. (2016).

We could not report previous relationships between out-of-school academic digital reading habits and reading comprehension in primary school students due to lack of research in this population. Nevertheless, some studies from high-school students also present the same negative correlation pattern with reading comprehension (Petko et al., 2017) or null associations (Park et al., 2020). Our findings confirm consistent negative associations between reading comprehension and digital reading habits in primary school, irrespective of reading purpose. These patterns follow metaanalytical evidence (Altamura et al., 2025) and support the claims of the shallowing hypothesis (Annisette & Lafreniere, 2017), which describes how frequent use of brief social media promotes rapid and relatively shallow thought, associated with cognitive and moral shallowness. Regarding motivation, we replicated positive correlations between leisure print reading and intrinsic motivation (Schiefele et al., 2012; Soemer & Schiefele, 2018; Troyer et al., 2019). As part of the MRHI validation process, we superficially addressed some unexamined questions that require further investigation. Specifically, to our knowledge, there are no studies that have addressed the relationship between motivation and out-of-school academic digital reading. We support the alignment of our results with previous literature indicating negative relationships between intrinsic

motivation and digital communicative texts (leisure), while being positively predicted by extrinsic motivation (McGeown et al., 2016). Future researchers can benefit from having an instrument that explicitly differentiates between leisure and academic reading purposes and accounts for different reading media dimensions to address this type of unexplored research questions.

3.4.3. Limitations

The MRHI is not exempt from limitations. First, it is necessary to acknowledge that all the students came from the same region, which can contribute to similarities in school curricula and activities, including homework load. We tried to tackle this issue recruiting different type of schools. It would be useful to count with students from other schools of Spain and other countries to examine, specifically, possible differences in academic reading habits. Second, the internal consistency reliability of the four dimensions could be higher. As we have discussed previously, it is hard to balance a sufficient number of items that guarantees representativeness of the constructs, facilitates internal consistency and that it does not contribute to students' fatigue (Devellis & Thorpe, 2022; Nunnally & Bernstein, 1994). Especially with young students, it is a challenging task to design assessment instruments that do not compromise their ecological application. If other researchers aimed to increase the number of items, caution is advised. Lastly, the present instrument is focused on the reading frequency. Other types of assessments could be used to triangulate and expand the knowledge about reading habits addressing behavioural variables, such as how long are the reading sessions, or examine the reading materials' characteristics, such as the number of pages or specific topics inside each genre. For example, employing digital devices that can track the reading behaviour of students (Parry et al., 2021), or reading diaries, in the case of print reading (Locher et al., 2023). Given the wide range of digital devices available, future research could investigate how reading habits vary across different platforms such as computers, tablets, e-readers, smartphones... A notable limitation of the MRHI in this regard is its focus on computers and tablets when

addressing digital reading. Expanding this scope to include smartphones could be particularly valuable, as, while they are less commonly used for extensive book reading (Levratto et al., 2021), they can play a significant role in information navigation and social communication.

3.5. Conclusion

The development of the MRHI and its validation process brings several educational implications and benefits. Firstly, its ease of application and rapid administration make it a practical tool for researchers and schools, allowing efficient data collection without imposing an overload of tests and scales on participants or administrators. It serves as a rapid and complementary measurement to a variety of variables related to reading processes and behaviours. Secondly, by providing a comprehensive measure that distinguishes between reading purposes (leisure or academic) and reading media (print or digital), this instrument offers a more precise understanding of students' reading habits. This allows educators to gain deeper insights into their students' reading behaviours, facilitating more tailored and effective teaching strategies. Furthermore, the MRHI emerges as a comprehensive tool proposed and encouraged to be freely used by researchers in their investigations to enhance the comparability and reliability of research findings across different contexts. Lastly, as it has been evidenced by criterion-validity, the reading habits dimensions correlate differently with reading comprehension and reading motivation. Thus, its use can help in monitoring changes in reading habits over time, assess the impact of educational interventions, and ultimately support the continuous improvement of reading programs to foster better reading comprehension and motivation among students.

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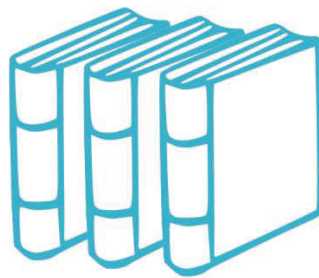
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Chapter IV



Study 3

*How digital reading habits shape reading motivation
and comprehension over time: longitudinal
associations in primary school*

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Chapter IV

Study 3 - How digital reading habits shape reading motivation and comprehension over time: longitudinal associations in primary school

4.1. Introduction

Reading comprehension is a critical skill for academic success and lifelong learning (Kendeou et al., 2007). Recent declining trends in comprehension rates among primary school students over the last decade (Mullis et al., 2023) highlight the urgent need to address barriers to its development. One such potential barrier is lacking reading motivation, which is an important drive for comprehension development (Orellana-García, 2018; Schiefele et al., 2012). As with comprehension levels, researchers have documented a decreasing trend in students' reading motivation, beginning in the school years (Miyamoto et al., 2020; Wigfield et al., 2015). In response to declining comprehension and motivation rates, educators and policymakers have explored ways to foster students' motivation to read, going beyond the use of printed texts. The increasing access to and integration of Information and Communication Technology (ICT) into formal and informal learning contexts has positioned digital devices as promising tools for enhancing reading motivation and, consequently, comprehension levels (Clark & Picton, 2019; Reinders et al., 2022). Their interactive features, multimedia capabilities, and wide access to information are often seen as affordances that stimulate reading motivation (Bus et al., 2020; Kucirkova, 2017). Contrary to this assumption, research on out-of-school reading habits reveals negative correlations between digital habits and motivation towards reading (Clark & Picton, 2019; McGeown et al., 2016). Furthermore, emerging evidence suggests that digital reading, often associated with rapid, surface-level engagement, may hinder the development of deep comprehension skills (Altamura et al., 2025). This phenomenon is central to the *digital chain hypothesis* (Wolf, 2018), which posits that the rapid, surface-level reading processing encouraged by digital formats may disrupt the development of

deep reading skills. Notably, most of the available literature has focused on leisure reading, and longitudinal studies are limited, leaving open gaps in our understanding of reading habits. Specifically, we know little about how different reading purposes, such as academic reading, might shape the long-term relationships between reading habits, motivation, and comprehension in early educational stages.

This study addresses these research gaps by following students from fourth to sixth grade, examining the longitudinal causal paths between their out-of-school digital reading habits, reading comprehension and reading motivation. Additionally, the study explores whether these relationships vary based on the purpose of reading, distinguishing between reading for leisure and reading for academic purposes. Before describing the study in depth, in the following sections we will contextualize our main variables and review up-to-date literature relevant to our study.

4.1.1. Reading habits: media and purposes

Reading habits are defined as the frequency of independent engagement in different reading activities (McGeown et al., 2015) and are also referred to as “reading frequency” or “reading amount” (for a review see Locher & Philipp, 2023). With the rise of technology integration, reading options have greatly expanded, encompassing both print and digital reading. These formats differ in the amount of information they provide and the types of reading activities they support (Bråten et al., 2020). On the one hand, print reading is typically characterized by a continuous and linear format, with information confined to the physical printed text. Printed texts tend to be edited, which ensures a certain degree of linguistic quality. Examples include reading books, magazines, comics, and newspapers. On the other hand, digital reading encompasses both activities analogous to print, such as reading static e-books, as well as other activities which are unavailable in print. For example, the Internet provides access to a vast array of hyperlinked web pages that facilitate quick information searches and social media platforms that enable instant communication with peers.

Also, as the Internet supports an open policy of publication, many available texts online have not been edited, and thus its linguistic quality cannot be ensured. To obtain accurate information about children's reading habits researchers need to consider and embrace such differences across reading media, going beyond "the narrow view that digital environments are simply print without paper" (McKenna et al., 2012, p. 299), as it ignores the nuances and affordances offered by digital reading. In this study, we emphasize the need to explore reading habits from a holistic approach that adapts to the current socio-educational context, which is in constant change. Large-scale assessments indicate that young readers are increasingly prioritizing reading that serves practical purposes, such as searching for immediate information or engaging in instant communication with peers (OECD, 2019). Such reading habits come hand by hand with a reduced frequency of print reading (Merga & Roni, 2017; Twenge et al., 2019).

When it comes to the volitional act of reading, large-scale assessments outline a decline in students' leisure reading, particularly in print, with around 50% of adolescents worldwide reporting that they read "only when they have to" or "to get the information that they need" (OECD, 2019). It is important to note that some students read at home not out of desire, but because it is necessary for studying or completing homework (McKenna et al., 2012). Therefore, it is crucial to distinguish not only the reading media but also the type of reading purposes. Research distinguishes two main types of reading purposes: reading for leisure (i.e. reading driven by intrinsic enjoyment) and reading for school (i.e. reading driven by school demands) (Locher & Philipp, 2023). Additionally, reading habits can take place in formal institutions (in-school reading) or outside (out-of-school) (Locher & Philipp, 2023). In this study, we will restrict our focus to out-of-school reading to guarantee a fair comparison between reading activities in which students engage in without the presence of a school instructor (Hong et al., 2004). Specifically, we will refer to leisure and academic reading habits, to distinguish them from in-school reading.

In the next sections, we will review how reading habits have been extensively associated with reading motivation and reading comprehension development, outlining differences and research gaps across reading media. Our primary focus will be on leisure digital reading habits, while also highlighting the comparatively limited literature on academic digital reading habits.

4.1.2. Reading habits and reading motivation

Motivation is defined as the drive that energizes and gives direction to our actions (Ryan & Deci, 2000). The Self Determination Theory (SDT) posits that motivation lies on a continuum of perceived autonomy. This refers to the degree to which individuals feel that their actions are self-endorsed and align with their personal values, interests, and goals, rather than feeling driven by external forces (i.e. controlling forces) (Ryan & Deci, 2000; 2017). The SDT describes two main motivation dimensions across the continuum of perceived autonomy: at the autonomous end, intrinsic motivation refers to engagement in activities driven by inherent interest and enjoyment, where the activity itself is experienced as rewarding. At the controlled end is extrinsic motivation, which encompasses behaviors performed to achieve external outcomes, such as obtaining rewards, gaining social approval, avoiding punishment, or achieving a valued goal. In this sense, the action is pursued for the sake of its outcome, not because the activity itself is inherently enjoyable (Ryan & Deci, 2000; 2017).

From these dimensions, intrinsic reading motivation has consistently been associated to more frequent leisure print reading among young students (Liao et al., 2022; McGeown et al., 2016; Schiefele et al., 2012; Soemer & Schiefele, 2018; Stutz et al., 2016). This association might arise because intrinsically motivated readers derive enjoyment and personal satisfaction from the act of reading itself. This inherent pleasure from reading fosters the feeling of reading as a rewarding and fulfilling experience. By contrast, extrinsic motivation tends to show null (McGeown et al., 2016; Stutz et al., 2016; Wang et al., 2020) to negative associations (Becker et al., 2010; Wang & Guthrie,

2004) with leisure print reading habits. Extrinsic motivation is driven by the external rewards a reader may gain, independent of the inherent enjoyment of the reading activity itself. When a reader perceives little external reward or goal achievement, their extrinsic motivation to read tends to diminish. Even though the SDT posits a continuum across intrinsic and extrinsic motivation dimensions, in specific contexts, like reading, such dimensions present an inverse relationship. It is important to analyze both motivation dimensions, as focusing on one could lead to spurious associations (Troyer et al., 2019; Wang et al., 2020). Notably, while studies have documented the relationships between reading habits and motivation in leisure print reading activities, the associations for academic purposes have received less attention. Limited cross-sectional evidence available shows mixed findings. Some studies evidenced positive predictions of intrinsic motivation to academic print reading habits while null for extrinsic (Wang & Guthrie, 2004). Other studies show no significant predictions from either intrinsic or extrinsic motivation (McGeown et al., 2016) and others show positive associations with reading motivation, combining both dimensions (Cox & Guthrie, 2001). This pattern of results underscores the need for further inquiry and longitudinal designs that can help infer approximate causal directions.

One notable research gap across this literature is that, despite the growing prevalence of digital devices and their integration into formal and informal educational contexts, the role of digital reading habits in shaping the development of reading motivation remains largely underexplored in relation to both leisure and academic reading habits. The available information comes mostly from in-school intervention studies that have shown positive effects of digitized reading environments on intrinsic reading motivation (Webber et al., 2023, for a review), even when using external rewards like gamification methods (Filsecker & Hickey, 2014). Such benefits are explained in terms of increased situational interest and reading engagement. Nevertheless, less is known about students' digital reading habits outside formal contexts. The extent to which students' autonomous digital reading habits foster intrinsic or extrinsic motivation is yet to be explored. For the best of

our knowledge, research examining the relationship of out-of-school digital reading habits and motivation has only focused on leisure reading purposes. One example is the large-scale surveys carried out by the National Literacy Trust assessing reading related perceptions and behaviors. This survey takes place annually in the United Kingdom involving participants from five to eighteen years old. Results from 60,000 students ranging from nine to eighteen years-old showed that those students with high leisure digital reading habits present also high disengagement, low reading enjoyment and low reading frequencies overall (Clark & Picton, 2019). Few empirical studies have examined the connections between digital reading habits and motivation in depth. One notable contribution is the work of McGeown et al. (2016), who analyzed UK primary school students' reading-related factors. Crucially, this study incorporated leisure digital reading habits, which included activities such as communicative digital reading, web browsing, and online searching. Their cross-sectional results revealed that intrinsic motivation negatively predicted leisure digital reading habits, whereas extrinsic motivation positively predicted them. One possible explanation could be related to the predominantly practical nature of reading on digital devices, like reading to meet a specific need. These needs typically correspond to social interaction (e.g., engaging in conversations with friends and peers) and information-seeking behaviors (e.g., searching for online information). Such practical features and the instrumentalization of digital reading might lead students to read solely to fulfil such needs, rather than reading for the intrinsic joy of the activity itself. McGeown et al.'s (2016) study represents a valuable starting point which we aim to extend. Specifically, our study expands the focus beyond the classical direction that goes from reading motivation to reading habits. To date, few studies have explored the reverse pathway (reading habits to reading motivation), which has received more attention on digital intervention studies (Webber et al., 2023). Some research has suggested that leisure digital reading might prevent students from engaging in deep reading strategies and reflective thinking (Baron et al., 2017). Other authors explain that the haptics of digital reading might contribute to a lack of reading engagement, since

digital environments often present few spatiotemporal cues (e.g., scrolling); and could even contribute to an unpleasant reading experience due to eye fatigue (Baron et al., 2017; Mangen & Pirhonen, 2022; Mangen & van der Weel, 2016). We argue that the lack of engagement with the reading activity itself and the instrumentalization of reading (i.e., to fulfill practical needs) could hinder the development of intrinsic motivation towards reading. In this study, we will explore both directions with a focus on out-of-school digital reading habits. Additionally, we will examine differences across leisure and academic reading purposes.

4.1.3. Reading habits and reading comprehension

Reading comprehension can be defined as the process of extracting and constructing meaning through interaction and engagement with written language (Snow, 2002). According to the reading for understanding framework (Snow, 2002), reading comprehension entails three main components: 1) the reader, considering the cognitive capabilities, previous knowledge and reading motivation of the individuals; 2) the text that is to be comprehended (either in print or digital format), and 3) the activity in which comprehension is required, including the purpose or reading goals. This framework emphasizes the interactions among these components, noting that comprehension is shaped by the interplay between them. These components are influenced by broader socio-cultural dynamics on reading comprehension. In today's digital era, digitalization has emerged as a key factor of socio-cultural change, reshaping the availability, format, and purposes of reading activities which potentially could influence the reader's cognitive and affective dimensions.

Previous research has systematically found positive associations between reading habits and reading comprehension skills (Allington & McGill-Franzen, 2021; Mol & Bus, 2011). This relationship has been characterized as bidirectional, meaning that the more time children spend reading, the better their reading comprehension skills and vice versa. Despite the bidirectionality of correlational studies, recent longitudinal literature suggests that reading comprehension tends to be

a stronger predictor of reading habits than the reverse (Bittmann, 2024; Erbeli et al., 2020; van Bergen et al., 2020). These studies have used longitudinal designs and analysis that can approximate causal claims, specifically, cross-lagged panel models (CLPM) and random-intercept cross-lagged panel models (RI-CLPM). Lastly, although not based on longitudinal data, studies with twin children support the view that it is reading comprehension which drives print reading habits, rather than the reverse (van Bergen et al., 2018). Altogether, this research indicates that reading comprehension skills are needed, as a prerequisite, to be able to engage in frequent print reading. One important research gap in this line of research is the limited knowledge about digital reading habits, as Bittman (2024) recently pointed out, particularly given the growing concerns about their influence on the development of reading comprehension.

With the advent of digital technologies, reading habits are changing, with digital texts now coexisting with print. Emerging evidence suggests that the integration of digital devices in reading habits is changing how readers process texts, with potentially relevant consequences on children's development. According to the digital chain hypothesis (Wolf, 2018), the rapid and fragmented nature of digital reading often promotes surface-level processing, as readers are frequently exposed to large volumes of information. Such scenarios encourage quick scanning rather than deep engagement. The outcome is a default shallow process when engaging in digital reading (Annisette & Lafreniere, 2017; Wolf, 2018). As a reaction to those changes in habits, editors tend to create simpler and shorter digital texts, which are best fit for digital consumption. Over time, exposure to such digital texts may prevent young readers from fully developing their reading comprehension skills, as manifested in lower ability to focus and make sense of large texts. A recent meta-analysis that explored the relationship between leisure digital reading habits and reading comprehension partially supports this hypothesis. The review, conducted by Altamura and colleagues (2025), concluded with 25 studies, involving almost 470,000 participants from 39 countries. The overall result represented a small positive correlation between leisure digital reading habits and reading

comprehension ($r = .055$). Such effect size contrasts to previous meta-analytic results that analyzed the effects of being exposed to print texts, with average effect sizes from 6 to 8 times bigger ($r = .36$ to $.41$) (Mol & Bus, 2011). Moreover, the relationship between leisure digital reading habits and reading comprehension varied across educational stages: in primary and middle school negative relationships were observed ($\beta = -.095$ and $\beta = -.025$), while at later stages, high school and university, the relationship turned out to be positive ($\beta = .085$ and $\beta = .070$). Interpretation of this data is limited to a correlational level, and longitudinal studies are needed to understand the dynamic interplay of digital reading habits and reading comprehension. To the best of our knowledge, only one study has examined this relationship. Torppa et al. (2020) followed a group of Finnish students from first to ninth grade, collecting information about their leisure reading habits (print and digital) and their reading comprehension skills. In this study, different RI-CLPM were carried out to examine reciprocal relations for print and digital reading habits separately with reading comprehension. Supporting previous results, Torppa et al. (2020) evidenced consistent positive predictions of print reading habits, especially book reading, to later reading comprehension skills. By contrast, results indicated that leisure digital reading habits presented mixed patterns depending on the academic year. For instance, reading comprehension during grade 1 and 2 positively predicted digital reading in grades 2 and 3; later on, higher reading comprehension in grade 4 predicted less digital reading in grade 6. Regarding the causal paths from digital reading to reading comprehension, positive paths were observed from grade 3 to 4, and from grade 4 to 6, whilst negative from grade 6 to 7. Altogether, the studies by Altamura et al. (2025) and Torppa (2020) underscore the need to explore how leisure digital reading habits are related to the development of reading comprehension during primary school, a critical period for forming foundational reading skills and attitudes (Brown, 2014).

Regarding academic reading habits, few studies with primary school students have explored the association with reading comprehension development. Contrasting with the positive relations

that leisure print reading habits presents with comprehension, the correlations between academic print reading habits and comprehension tend to be null. These findings have been consistent through decades, from the early 2000's with Cox and Guthrie (2001) and Wang and Guthrie (2004) studies, which include primary school students from the United States and China to the current days in the Spanish context (Vargas et al., 2024a). Additionally, to the best of our knowledge few studies have explored associations between out-of-school academic digital reading habits and reading comprehension in primary school students. Such cross-sectional studies, like the ones carried out by Skovdahl et al. (2025) and Vargas et al. (2024a), also support the digital chain hypothesis, revealing negative associations between academic digital reading habits and reading comprehension. Studies that have explored secondary-school students' use of ICT to do homework at home found similar results, exhibiting negative (Park & Weng, 2020) to null associations with reading comprehension (Petko et al., 2017) in over 39 PISA participating countries.

The scarce evidence on academic reading habits in primary school students, coupled with the negative trends associated with digital reading, underscores the need for further research into their long-term effects on reading comprehension. In the present study, we aim to investigate the longitudinal causal paths between digital reading habits and reading comprehension, while distinguishing between leisure and academic reading purposes.

4.1.4. Reading habits, motivation and comprehension

So far, we have reviewed studies that addressed associations between reading habits and motivation or reading habits and comprehension skills. Next, we will introduce literature that has addressed the link between reading comprehension skills and reading motivation, while also considering the links with reading habits. Reading motivation has been extensively associated with reading comprehension skills (Orellana-García, 2018), outlining intrinsically motivated readers as more likely to engage with the reading process (Guthrie & Wigfield, 2000). Such engagement is often

represented by a high use of deep processing strategies, such as inference-making and critical analysis, essential for meaningful comprehension (Liao et al., 2022). By contrast, students who are extrinsically motivated often rely on surface-level strategies, such as memorization or rehearsal, which can hinder deeper understanding (Schiefele et al., 2012). In this regard, studies have found null (Schiefele et al., 2016) and negative associations (Kanonire et al., 2022; Schaffner et al., 2013; Stutz et al., 2016; Troyer et al., 2019; Wang et al., 2020) of extrinsic motivation with reading comprehension.

The positive relationship between reading motivation and reading comprehension has often been related to the concept of a virtuous reading circle (Locher & Pfof, 2020; Pfof et al., 2014). This circle describes a positive feedback loop in which reading comprehension, reading motivation, and reading habits reinforce one another. According to this, students with initial low reading comprehension may feel less motivated to read, leading to reduced reading frequency. This lack of practice, in turn, further hinders their comprehension development and deepens their low motivation. Over time, those with initial good reading skills continue to improve, while those who struggle fall further behind, as described by the Matthew effect (Stanovich, 1986). Importantly, one research gap is identified. When addressing reading habits, reading motivation and reading comprehension skills with longitudinal design studies have mostly focused on leisure print reading habits (Schiefele et al., 2012; Schiefele et al., 2016; Soemer & Schiefele, 2018; Troyer et al., 2019; Wang et al., 2020). As suggested by the scarce literature available, digital reading habits could play a different role in this virtuous circle, as their relationship with reading comprehension and intrinsic motivation tends to be null or even negative, particularly in young students (Altamura et al., 2025; McGeown et al., 2016).

Moreover, we highlight a second research gap regarding the causality of the relations between reading habits, reading motivation and reading comprehension. Commonly, studies that have studied these three variables have not employed designs that allow causal approximations. To

date, only studies addressing reciprocal long-term relationships between reading habits and reading comprehension have employed analyses that account for autoregressive effects (CLPM), and that have separated between from within variance (RI-CLPM) (e.g., Bittman, 2024; Torppa et al., 2020; van Bergen et al., 2020). Nevertheless, no such study has included reading motivation. Alternatively, studies that have included these three variables typically test a determined direction, analyzing the role of reading habits as a mediator on the effects from motivation to reading comprehension (reading motivation $\rightarrow$ reading habits $\rightarrow$ reading comprehension). Most of the studies included in Schiefele et al., (2012) review tested this direction, yielding inconclusive results. Further studies from the last decade have followed this approach, with some supporting the mediator role of reading habits between reading motivation and reading comprehension (Liao et al., 2022; Soemer & Schiefele, 2018; Stutz et al., 2016; Wang et al., 2020), and some others not finding supporting evidences (Troyer et al., 2019). Additionally, a few studies have tested the reverse direction and have found that reading comprehension is a relevant predictor for reading motivation (Schiefele et al., 2016; Soemer & Schiefele, 2018).

One important methodological aspect is that longitudinal studies examining these associations are scarce (e.g., Soemer & Schiefele, 2018; Troyer et al., 2019). Commonly, variables in these studies are not measured at all time-points and tend to analyze only the direction from reading motivation $\rightarrow$ reading habits $\rightarrow$ reading comprehension. While such studies can bring relevant insights, they cannot analyze causal paths. In our study, we aim to fill in these gaps by following a sample of Spanish primary school students from grade 4 to 6. To examine the possible causal paths between digital reading habits, reading comprehension, and reading motivation and their directions, we will employ two complementary analyses that are aimed to support causal claims: cross-lagged and random-intercept cross lagged panel modelling. Additionally, we will differentiate between leisure and academic reading purposes.

4.1.5. This study

As we have reviewed, most of the longitudinal studies addressing the role of reading habits in predicting reading motivation and reading comprehension have focused on leisure print reading. Additionally, the inconclusive findings regarding reading habits as a mediator between motivation and reading comprehension, along with growing evidence in the literature supporting a stronger predictive path from reading comprehension to reading habits than vice versa, highlight the need to explore alternative pathways.

In this study, we are interested in how new digital reading habits are related to reading motivation and reading comprehension of primary school students over the course of three years, and how such relationships might differ across leisure and academic reading purposes. Because we are interested in examining causal pathways and their specific directionality, we will employ two complementary types of longitudinal analyses: cross-lagged panel models (CLPM) and random-intercept cross lagged panel models (RI-CLPM). Of note is that proving causality is a rather unrealistic aim in educational research overall. CLPM, and more specifically RI-CLPM, allow robust control for autoregressive effects over time, and isolate long-term paths, being one of the closest methodologies to support causal claims, besides twin studies (Bittman, 2024). Our study aims to explore if there are any causal paths between digital reading habits, reading motivation and reading comprehension. Additionally, we sought to explore if there are differences in such paths depending on the reading purpose (for leisure or for academic reasons).

4.2. Method

4.2.1. Data and participants

Data collection took place during the months of March to June in 2022 (fourth grade), 2023 (fifth grade) and 2024 (sixth grade). In total, 908 students participated in the data collection (50% girls).

In Spain the minimum age at fourth grade is 9 years-old, and the maximum at sixth grade is 12 years, except for grade repeaters who can be one year older. 16 schools collaborated, 26.8% were public and 73.2% were non-public. Non-public schools include private and state-subsidized schools, which in Spain share the same self-administrative aspect. 11.7% of the participants had a diagnosed or duly reported special education need (SEN), which ranged from learning disorders (e.g., reading or language impairments) to developmental disorders (e.g., autism or intellectual disabilities). Aiming to increase visibility of SEN students in developmental research, we opted to include all students in the analyses, regardless of their condition. In the analyses, SEN status was entered as a time-invariant control variable. The number of participants at each measurement point varies, as some students were unable to attend the assessment on the scheduled day due to various reasons, such as medical appointments, illness, conflicts with other extraordinary school assessments, or school transfers. Notably, one school dropped out during the second wave due to a decision made by its board. Little's MCAR test was conducted to assess the missing data mechanism. The test yielded a significant result, $\chi^2(3056) = 3602, p < .001$, indicating that the data are not missing completely at random (MCAR). This suggests that the pattern of missingness may be systematic and should be addressed using appropriate missing data techniques, like full information maximum likelihood (FIML) (Schafer & Graham, 2002). Table 4.1 presents detailed information about the percentage of students that were present when data collection took place.

The Research Ethics Commission of the University of Valencia approved the protocol of the study (register # 1894095). APA ethical standards and the guidelines of the Helsinki Protocol were followed in conducting the study. Parents or legal guardians signed an informed consent form in each of the assessment waves.

Table 4.1

Students that were present when data collection took place across the different measurement points

Grades	Students present	Percentage
All (4-5-6)	616	67.8
4 & 5	42	4.6
4 & 6	26	2.9
5 & 6	27	3.0
Only 4	90	9.9
Only 5	43	4.7
Only 6	64	7.0

4.2.2. Instruments

4.2.2.2.1. Digital reading habits

We assessed reading habits with the Multidimensional Reading Habits Instrument for primary school students (MRHI, Altamura et al., in press). This instrument contains two questionnaires, one per reading purpose: leisure and academic. Each questionnaire includes eight items, half of them refer to print reading activities and half refer to digital reading activities. Students answer on a 4-point scale: "Never or almost never", "Once or twice a month", "Once or twice a week", "Every or almost every day". The MRHI is a validated instrument⁴ with good internal consistency indices for both questionnaires, each distinguishing a print and digital factor (Leisure: $RMSEA = .052$, 90% $CI [.043, .061]$; $CFI = .900$; $SRMR = .042$; Academic: $RMSEA = .023$, 90% $CI [.013, .033]$; $CFI = .986$; $SRMR = .026$). In our sample, composite reliability scores, based on factor loadings (Raykov, 1997), indicate that leisure and academic digital reading habits presented composite reliability

⁴ Data from 2,077 participants were used to validate the MRHI (Altamura et al., in press), of which 716 correspond to participants in the present study.

scores close to acceptable thresholds, taking .60 as a suggested cut-off (Netemeyer et al., 2003). For leisure digital reading habits, scores were .61 in grade 4, .54 in grade 5, and .50 in grade 6. For academic digital reading habits, scores were .67 in grade 4, .64 in grade 5, and .62 in grade 6. The complete questionnaire is available at Appendix B (Supplemental materials B1).

4.2.2.2. *Intrinsic reading motivation*

We used a reading motivation scale adapted by Mañá et al. (2023) from an expanded version of the ESMS-E scale (Ramos et al., 2022). Each item is a statement on which students indicate their degree of agreement on a five-point scale from 1 (strongly disagree) to 5 (strongly agree). We used the dimensions of intrinsic and extrinsic motivation, specifically the external dimension. Intrinsic motivation items were: “I like reading”, “Reading interests me a lot”, “I read even when I don’t have to”. Extrinsic motivation items were: “I read to get a nice reward”, “I read to please my parents or my teacher”, “I read to avoid problems with my teacher or my parents”. A CFA from Mañá et al. (2023)⁵ confirmed the good psychometric properties (CFI = .994, RMSEA = .040 [.033, .048], SRMR = .036). Composite reliability scores for the study sample revealed consistent moderate to high internal consistency. For intrinsic motivation, scores were .84 in grade 4, .86 in grade 5, and .91 in grade 6.

4.2.2.3. *Reading comprehension*

We used the *Reading Comprehension Assessment* tests (ACL; Català et al., 2001) to measure reading comprehension in each academic year. We used the corresponding version for each grade. These tests present narrative, expository, and texts with graphic information. The questions were multiple choice with 5 alternatives, covering different dimensions of reading comprehension, as described by the original authors: literal, inferential, evaluation, and synthesis of information. In

⁵ Data from 2,302 participants were used in Mañá et al. (2023) validation study, of which 775 correspond to participants in the present study.

Appendix C we provide a detailed description of the type of texts and items for each grade (Supplemental materials C1, C2 and C3), additionally we also present a narrative description for the four types of questions (translated into English) in Supplemental materials C4. The ACL tests have different texts and item sets for different grades. In grade 4 there were 8 texts with 28 corresponding items across texts. In grade 5 there were 10 texts with 35 corresponding items. Lastly, in grade 6 there were 10 texts, with 36 corresponding items. Composite reliability scores indicate high internal consistency in all grades versions: grade 4 = .94, grade 5 = .90, grade 6 = .91. Reading comprehension scores in this study are WLE scores (Warm, 1989) from a Rasch model applied to the ACL test data from the three measurement occasions. WLE scores are interval-scale estimates centered around zero, where a score of 0 indicates average reading comprehension relative to the reference sample. Positive values reflect above-average ability, while negative values indicate below-average performance. To link the reading comprehension scales between the three measurement points, we included 6 additional items at grade 5 from the item-set of grade 4 as anchoring items, and 7 additional items from grade 5 to anchor in grade 6. We used a fixed parameters calibration based on the anchor-items design (see Fischer et al., 2019).

4.2.2.4. Control variables

To ensure robust longitudinal relationships, we included control variables at student, home and school level. These variables were selected based on prior literature (see below). Given that our data presents repeated measures across waves, some variables are treated as time-invariant, assumed to remain stable over time, while others are considered time-variant, as they are expected to change. In our study, time-invariant control variables include gender and SEN status at the student level; number of books at home at home level; and school type at the school level. Time-variant control variables include print reading habits and extrinsic motivation at the student level, and access to digital devices in schools at school level. Except the latter, time-variant measures at the student-level were collected in all three measurement occasions.

Time-invariant control variables

First, gender was considered as a control variable because current research has shown different associations between gender and our study variables. First, recent large-scale data of fourth graders from PIRLS 2021 indicates no significant differences in either digital reading habits (Mullis et al., 2023), nor reading comprehension across girls and boys (Mullis et al., 2017; 2023). This holds for the global average level and also for the specific case of Spain. Such pattern challenges common assumptions that favour girls in both print reading frequency and reading comprehension (Chiu, 2018). Nevertheless, research appears to be consistent in finding higher levels of motivation for girls, compared to boys (Mullis et al., 2023). This variable was codified as a dummy variable (0=girls, 1=boys). Second, SEN status was also considered as a control variable. This is an important individual difference, as initial reading comprehension skills tend to be lower for students with SEN (Scarborough, 2005; Vargas et al., 2024). Additionally, SEN students can experience low levels of reading motivation (Lee & Zentall, 2015), as learning difficulties and developmental disorders might prevent reading enjoyment (Sideridis et al., 2006). Lastly, research about digital reading habits on students with SEN is scarce and presents mixed results. Although some studies find no significant differences (Vargas et al., 2024), others report that students with low comprehension levels are less likely to engage in digital reading habits (Kanniainen et al., 2022). Lastly, we considered the number of books at home as a relevant environmental literacy factor. The number of books at home can contribute to higher reading frequency and reading enjoyment, possibly due to higher access to reading materials, but also, due to more frequent family reading activities or reading role-models (Claes et al., 2024). In our study, the number of books at home was measured using a scale ranging from 0 to 4, in which 0= 0–10 books, 1=11–25 books, 2= 26–100 books, 3= 101–200 books, and 4= more than 200 books. Each option was accompanied by a graphical representation of a bookshelf. Even though we acknowledge that families can increase the number of books at home from one year to another, this is conceived as an overall indicator of

environmental literacy, therefore we employed the scores collected in grade 4. At the school level, we controlled for the type of school, whether it was a public (0) or non-public school (1). This is another environmental factor that might be relevant to control, as it reflects students' families socioeconomic status and relates to access to different resources (e.g., more digital resources or extracurricular activities) (Gustafsson et al., 2011; Mancebón & Muñiz, 2008). Research has indicated that students attending private schools often present higher socioeconomic status (SES) than those in public schools (Mancebón & Muñiz, 2008). In turn, those students with higher SES tend to show higher reading comprehension (Romeo et al., 2022) and reading motivation (Stutz et al., 2016).

Time-variant control variables

Regarding time-variant control variables, we first proposed print reading habits at student level. By controlling for print reading habits, we expect to better isolate the long-term associations of digital reading habits with reading motivation and reading comprehension. Leisure print reading habits presented low reliability scores (grade 4= .20, grade 5= .38, grade 6= .43). Academic print reading habits also presented low reliability scores (grade 4= .49, grade 5= .55, grade 6= .51). Another student-level control variable that was proposed was extrinsic motivation. As previous literature has indicated, both dimensions should be addressed to prevent spurious relationships (Troyer et al., 2019). Extrinsic motivation composite reliability scores were acceptable (grade 4= .75, grade 5= .71, grade 6= .72). Lastly, at the school-level, teachers reported the level of digital device access in each grade, from now on: school digital access level. They selected from: 0 = The center has computers/laptops/tablets that the class can sometimes use; 1 = The class has computers/laptops/tablets that students can share; 2 = Each student has a computer/laptop/tablet. This indicator offers additional insight into school-level disparities that may intersect with students' socioeconomic background (González-Betancor et al., 2021), and exposure to instructional reading activities on digital devices (Xiao & Hew, 2022).

4.2.3. Procedure

Assessment sessions generally took place in the reference classroom in a session of about 90 minutes. All tests and questionnaires were completed individually as paper and pencil tasks. There was always at least one examiner per group who guided the session, following a common script. Students first completed the reading comprehension test, followed by the reading habits and motivation questionnaires. Students were given instructions on how to answer the scales of the different questionnaires. Teachers provided information regarding school type and the level of digital access in each corresponding grade.

4.2.3. Analysis

First, descriptive and correlational analyses were conducted to provide an overview of our sample characteristics. The correlation matrix was also employed to conduct methodological checks regarding our control variables. Specifically, we examined whether print reading habits, proposed as time-varying control variables at the student level, were significantly associated with their corresponding outcome variables, namely digital reading habits. The decision to include these variables as controls in the final models was contingent upon the significance of these associations. In cases where the correlations were not statistically significant, print reading habits were excluded from subsequent analyses to avoid unnecessary model complexity and the risk of overfitting (Kline, 2016). Unlike the other control variables, print reading habits were the only controls that varied by reading purpose and were therefore model-specific. All the other control variables were common to both models and were consistently included in both the leisure and academic reading models as standard controls. For dummy control variables (gender, SEN status, and type of school) we provide mean comparison tests for all study variables in Appendix C in Tables C1, C2 and C3.

Second, the main analyses in this study are two complementary but distinct types of longitudinal structural equation models: the Cross-Lagged Panel Model (CLPM) and the Random

Intercept Cross-Lagged Panel Model (RI-CLPM). Reporting both models is crucial, as this is the first study, to our knowledge, that simultaneously investigates digital reading habits, reading motivation, and reading comprehension over time. Each model addresses slightly different research questions and offers unique insights into the dynamics among these three variables. Traditionally, the CLPM has been the standard approach for modeling hypothesized reciprocal relationships between variables over time. This model accounts for autoregressive effects (i.e., stability of constructs over time) and allows for cross-lagged paths (i.e., directional influences between constructs across time points), thus capturing potential dynamic interplay between variables. The CLPM estimates total effects, encompassing both within-person and between-person variance. In other words, it models how individual differences in a variable at an earlier time point predict differences in another variable at a later time point. The resulting estimates reflect general sample-level trends and are aligned with the types of models typically employed in longitudinal studies using structural equation modeling (SEM). However, recent research has highlighted several limitations of CLPMs, particularly regarding their ability to isolate causal within-person processes, due to their conflation of between- and within-person variance (Hamaker et al., 2015; Usami, 2021). To overcome some of these limitations, we also employed the RI-CLPM, following previous studies that have examined reading habits and reading comprehension co-development (Bittman, 2024; Torppa et al., 2020, van Bergen et al., 2020). This model removes time-invariant, trait-like individual differences by incorporating random intercepts, effectively separating stable between-person differences from dynamic within-person fluctuations. The RI-CLPM examines changes within individuals over time by comparing each person to their own past scores, rather than to the group average. This focus on person-centered changes allows for a more causal interpretation of temporal effects, as it models whether within-person increases in one variable are associated with within-person changes in another variable.

Given the inclusion of three variables (digital reading habits, reading comprehension, and reading motivation) measured at three time points, as well as both time-invariant and time-varying control variables, we opted to work with aggregated scale scores (i.e., observed composite variables). In this way, we would aim to obtain parsimonious models, without compromising estimation stability and statistical power (Little, 2013; MacCallum et al., 1996). To control for measurement error, we fixed each indicator's error variance to the inverse of its estimated reliability multiplied by its variance (Brown, 2015), following previous similar studies (e.g., Grande et al., 2024). Analyses were conducted using Robust Maximum Likelihood estimation (MLR) estimator in Mplus 8.8 (Muthén & Muthén, 1998-2017). Full information maximum likelihood (FIML) method was used to handle missing data, which assumes data are missing at random (MAR). Model fit was assessed using four indicators: chi-square test, comparative fit index (CFI), root-mean-square error of approximation (RMSEA), and standardized root-mean-square residual (SRMR). These indicators suggest good model fit when chi-square test reflects small, and ideally not significant chi-square values; CFI greater than .95 (>.90 considered acceptable); RMSEA under 0.05 (< 0.08 considered acceptable); and SRMR less than .05 (< .80 considered acceptable) (Hair et al., 2010; Hu & Bentler, 1999). Of note is that these are suggested indicators of model fit and should not be considered as strict cut-off values. Some indexes might vary according to sample size and should not be interpreted alone, like chi-square values, that tend to be nonsignificant with large samples (Hair et al., 2010, p. 641).

All the datasets, analyses and corresponding syntax carried out in this study can be found in the supplementary online materials. This study was not preregistered.

4.3. Results

4.3.1. Descriptive summary

In Table 4.2, we present the descriptive statistics for all variables. Among our sample, we observe an increasing trend for both digital reading habits, for leisure and for academic reasons, with students typically reporting reading "once or twice a month" towards "once or twice a week". This upward trend was also identified in the academic print reading habits, which presented the highest averages in all grades, generally reading "once or twice a week". By contrast, print reading for leisure purposes was the least frequent reading habit, showing a decreasing trend from grade 4 (when students tended to indicate "Once or twice a month") to grade 6 (when they tended to indicate "Never or almost never").

In terms of reading motivation, students presented high levels of intrinsic reading motivation in all grades, while reporting lower levels of extrinsic reading motivation, approximately half as much. Regarding reading comprehension skills, different average scores were observed across measurement points. In grade 4, students exhibited average reading comprehension levels, as indicated by a mean WLE score close to 0. In grade 5, their scores reflected higher achievement but still close to average levels. In grade 6, the same students demonstrated above-average reading comprehension skills, accounting for item difficulty on the assessment.

Regarding environmental factors, we observe that the level of digital access at school progressively increased from grade 4 to 6, when students, on average, had classroom-level access to digital devices. Lastly, students were found to have a moderate number of books at home, approximately between 26 and 200.

In Appendix C, Table C4, we present a correlation matrix with bivariate associations between all the study variables to inform the methodological checks we carried out to prevent model overfit in the longitudinal models.

Table 4.2*Descriptive statistics for the study variables*

	<i>N</i>	<i>Missing</i>	<i>Mean</i>	<i>SD</i>	<i>Min.</i>	<i>Max.</i>
<i>Dependent variables</i>						
Leisure digital reading habits						
Grade 4	751	157	1.35	0.75	0	3
Grade 5	705	203	1.51	0.71	0	3
Grade 6	719	189	1.60	0.66	0	3
Academic digital reading habits						
Grade 4	751	157	1.16	0.73	0	3
Grade 5	686	222	1.36	0.71	0	3
Grade 6	708	200	1.39	0.70	0	3
Intrinsic reading motivation						
Grade 4	721	187	2.68	1.02	0	4
Grade 5	681	227	2.47	1.09	0	4
Grade 6	700	208	2.32	1.18	0	4
Reading comprehension						
Grade 4	772	136	-0.02	1.12	-3.76	3.71
Grade 5	726	182	0.61	0.87	-2.30	5.12
Grade 6	732	176	1.29	0.89	-0.99	4.93
<i>Time-invariant control variables</i>						
Books at home	859	49	2.57	1.13	0	4
<i>Time-variant control variables</i>						
Leisure print reading habits						
Grade 4	750	158	1.13	0.55	0	3
Grade 5	694	214	1.05	0.59	0	3
Grade 6	721	187	0.80	0.64	0	3
Academic print reading habits						
Grade 4	739	169	1.99	0.60	0	3
Grade 5	689	219	2.09	0.55	0	3
Grade 6	709	199	2.03	0.54	0	3
Extrinsic reading motivation						
Grade 4	737	171	1.34	1.21	0	4
Grade 5	695	213	1.22	1.11	0	4
Grade 6	723	185	1.09	1.07	0	4
School digital level access						
Grade 4	908	0	0.66	0.92	0	2
Grade 5	908	0	0.95	0.98	0	2
Grade 6	908	0	1.11	0.98	0	2

Note. All presented values are average scores. Reading comprehension scores are WLEs from a Rasch model where 0 represents average scores.

The correlation matrix revealed that print and digital leisure reading habits were not significantly correlated (all p -values $> .05$), thus, we decided to exclude leisure print reading habits as control variable in the longitudinal models. By contrast, print and digital academic reading habits correlated significantly in grade 4 ($r = .25, p < .001$), grade 5 ($r = .15, p < .001$), and grade 6 ($r = .21, p < .001$), supporting the decision to keep this control variable.

4.3.2. Cross-lagged panel models

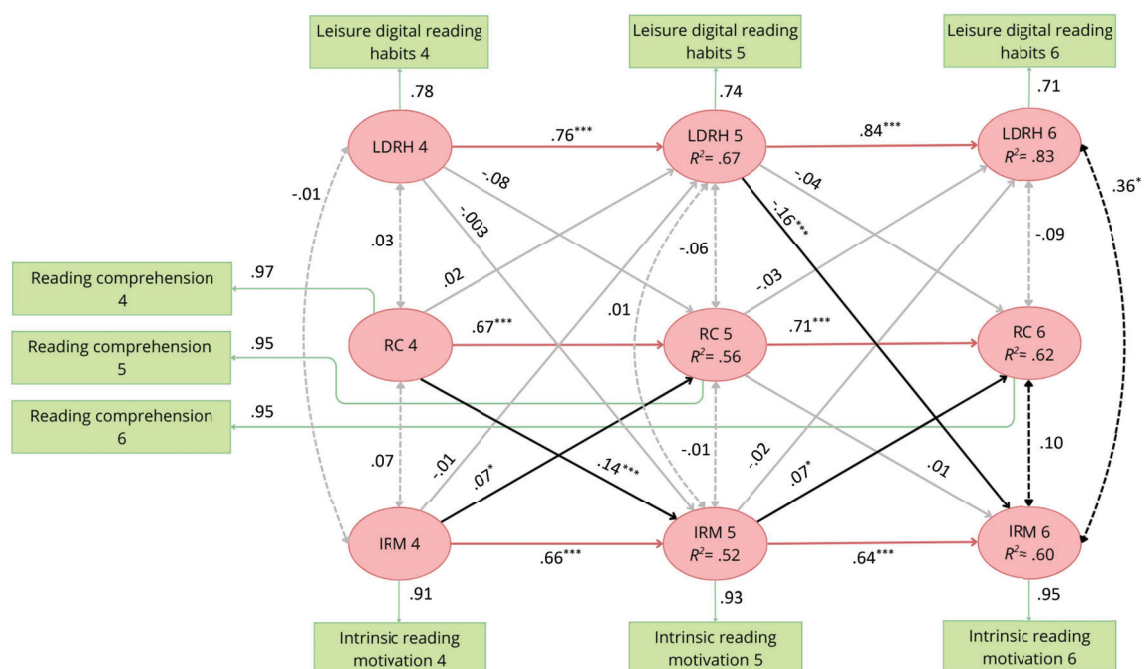
In this section, we present the two CLPM that were fitted, one for leisure and one for academic digital reading habits. Each model standardized estimates are graphically represented in Figures 4.1 and 4.2, respectively. For visual clarity, estimates from the control variables are omitted in the graphs, and presented in Tables 4.3 and 4.4. Both models adequately fitted the data, for leisure: $\chi^2(66) = 225.86, p < .001$; $RMSEA = .054$, 90% CI [.046, .061], $CFI = .938$; $SRMR = .052$; and for academic reading purposes: $\chi^2(105) = 343.99, p < .001$; $RMSEA = .052$, 90% CI [.046, .058], $CFI = .919$; $SRMR = .052$. These values indicate adequate model fit. Even if the χ^2 tests were significant, this was expected due to sample size sensibility.

Both CLPMs accounted for a substantial proportion of variance in the endogenous variables, with R^2 values ranging from .45 to .83, indicating that the predictors explained a meaningful share of variance over time. All estimates reported are standardized coefficients, which represent the expected change in the outcome variable (in standard deviation units) associated with a one standard deviation increase in the predictor, while controlling for the other variables in the model. In both models, all autoregressive paths were significant, suggesting that earlier levels of each construct strongly influenced their subsequent levels. Regarding cross-lagged paths, both models showed reciprocal associations between reading comprehension and intrinsic reading motivation from grade 4 to grade 5, with stronger paths from reading comprehension to intrinsic reading motivation than the reverse. After controlling for autoregressive effects from grade 4, the path from reading

comprehension in grade 5 to intrinsic motivation in grade 6 was no longer significant, while intrinsic motivation continued to predict later reading comprehension. In both models, digital reading habits in grade 5 predicted decreases in intrinsic reading motivation in grade 6. This negative effect also appeared earlier, from grade 4 to 5, only in the academic digital reading model. No significant cross-lagged paths were observed between digital reading habits and reading comprehension in neither model. Only one significant negative residual covariance was found between academic digital reading habits and reading comprehension in grade 5. Lastly, both models showed negative residual covariances between leisure and academic digital reading habits and intrinsic motivation in grade 6.

Figure 4.1

Cross-lagged panel model for the development of leisure digital reading habits, reading comprehension and intrinsic reading motivation



Note. All paths represent standardized estimates. Dashed lines represent covariances. Control variables were included in the model but are omitted in the figure for clarity: gender, SEN status, books at home, type of

school, extrinsic reading motivation, school digital access level. LDRH: Leisure digital reading habits; RC: Reading comprehension, IRM: Intrinsic reading motivation; 4: grade 4; 5: grade 5; 6: grade 6. Significant paths are also indicated with dark arrows to facilitate comprehension. * $p < .05$, ** $p < .01$, *** $p < .001$.

Table 4.3

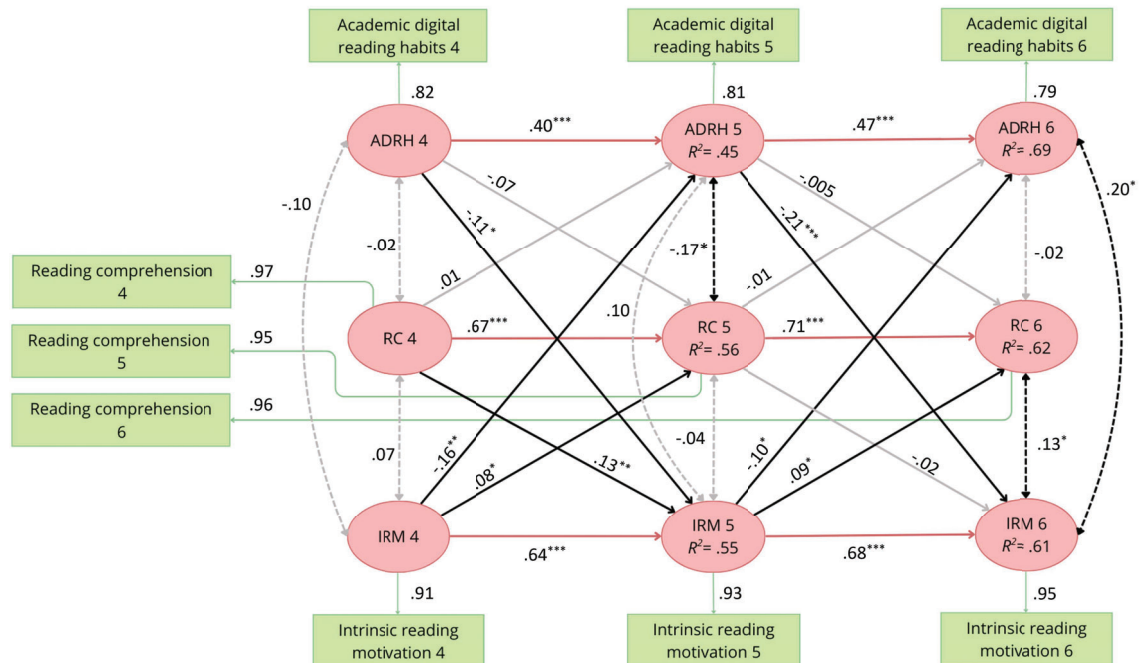
Control variables standardized estimates from the leisure cross-lagged panel model

	Leisure digital reading habits			Reading comprehension			Intrinsic reading motivation		
	Grade 4	Grade 5	Grade 6	Grade 4	Grade 5	Grade 6	Grade 4	Grade 5	Grade 6
<i>Time-invariant</i>									
Gender	-.10*	-.06	-.12*	-.02	.05	-.01	-.18***	-.05	-.08*
SEN	.06	-.05	-.08	-.34***	-.03	-.06	-.07	.02	-.10**
Books at home	-.05	-.03	.01	.18***	.02	.09**	.17***	-.10*	.13***
School type	.03	-.02	-.08	.12**	.01	.03	.02	.04	-.13***
<i>Time-variant</i>									
Extrinsic reading motivation	.24***	.14*	.12	-.24***	-.12**	-.05	-.19***	-.09	-.05
School digital access level	.25***	.08	.07	-.02	.07*	-.06	-.08	.00	.03

Note. Gender: 0=Girls, 1=Boys; SEN status: 0= No, 1= Yes; Books at home: 0= 0–10 books, 1=11–25 books, 2= 26–100 books, 3= 101–200 books, and 4= more than 200 books; School type: 0= Public, 1= No-public; School digital access: 0 = The center has computers/laptops/tablets that the class can sometimes use; 1 = The class has computers/laptops/tablets that students can share; 2 = Each student has a computer/laptop/tablet. * $p < .05$, ** $p < .01$, *** $p < .001$.

Figure 4.2

Cross-lagged panel model for the development of academic digital reading habits, reading comprehension and intrinsic reading motivation



Note. All paths represent standardized estimates. Dashed lines represent covariances. Control variables were included in the model but are not displayed in the figure for clarity: gender, SEN status, books at home, type of school, academic print reading habits, extrinsic reading motivation, school digital access level. ADRH: Academic digital reading habits; RC: Reading comprehension, IRM: Intrinsic reading motivation; 4: grade 4; 5: grade 5; 6: grade 6. Significant paths are also indicated with dark arrows to facilitate comprehension. * $p < .05$, ** $p < .01$, *** $p < .001$.

Table 4.4

Control variables standardized estimates from the academic cross-lagged panel model

	Academic digital reading habits			Reading comprehension			Intrinsic reading motivation		
	Grade 4	Grade 5	Grade 6	Grade 4	Grade 5	Grade 6	Grade 4	Grade 5	Grade 6
<i>Time-invariant</i>									
Gender	-.08	-.03	-.02	-.02	.05	-.01	-.16***	-.05	-.07*

Table 4.4 (continued)

	Academic digital reading habits			Reading comprehension			Intrinsic reading motivation		
	Grade 4	Grade 5	Grade 6	Grade 4	Grade 5	Grade 6	Grade 4	Grade 5	Grade 6
SEN	.02	.00	-.03	-.34***	-.04	-.06	-.04	.03	-.10**
Books at home	-.02	-.02	.03	.18***	.02	.09**	.17***	-.10*	.13***
School type	.02	.12*	.05	.11**	.02	.03	-.02	.05	-.11**
<i>Time-variant</i>									
Academic print reading habits	.41***	.25***	.32***	.03	.04	-.08	.37***	.22***	.11*
Extrinsic reading motivation	.31***	.14*	.26***	-.24***	-.12**	-.05	-.19***	-.07	-.03
School digital access level	.30***	.23***	.30***	-.02	.07*	-.07	-.06	.04	.07

Note. Gender: 0=Girls, 1=Boys; SEN status: 0= No, 1= Yes; Books at home: 0= 0–10 books, 1=11–25 books, 2= 26–100 books, 3= 101–200 books, and 4= more than 200 books; School type: 0= Public, 1= No-public; School digital access: 0 = The center has computers/laptops/tablets that the class can sometimes use; 1 = The class has computers/laptops/tablets that students can share; 2 = Each student has a computer/laptop/tablet. * $p < .05$, ** $p < .01$, *** $p < .001$.

4.3.3. Random-Intercept Cross-Lagged

In Figures 4.3 and 4.4 we present the random-intercept cross-lagged panel models that were fitted for leisure and academic digital reading habits, respectively, with standardized estimates. These estimates represent the expected change in the outcome variable (in standard deviation units) associated with a one standard deviation increase in the predictor, while controlling for the other variables in the model. For visual clarity, estimates from the control variables are omitted. These estimates are presented in Table 4.5, for leisure, and Table 4.6, for academic digital reading habits.

Model fit for both models was adequate, for leisure: $\chi^2(84) = 274.25$, $p < .001$; $RMSEA = .052$, 90% $CI [.045, .059]$, $CFI = .927$; $SRMR = .058$; and for academic reading purposes: $\chi^2(123) =$

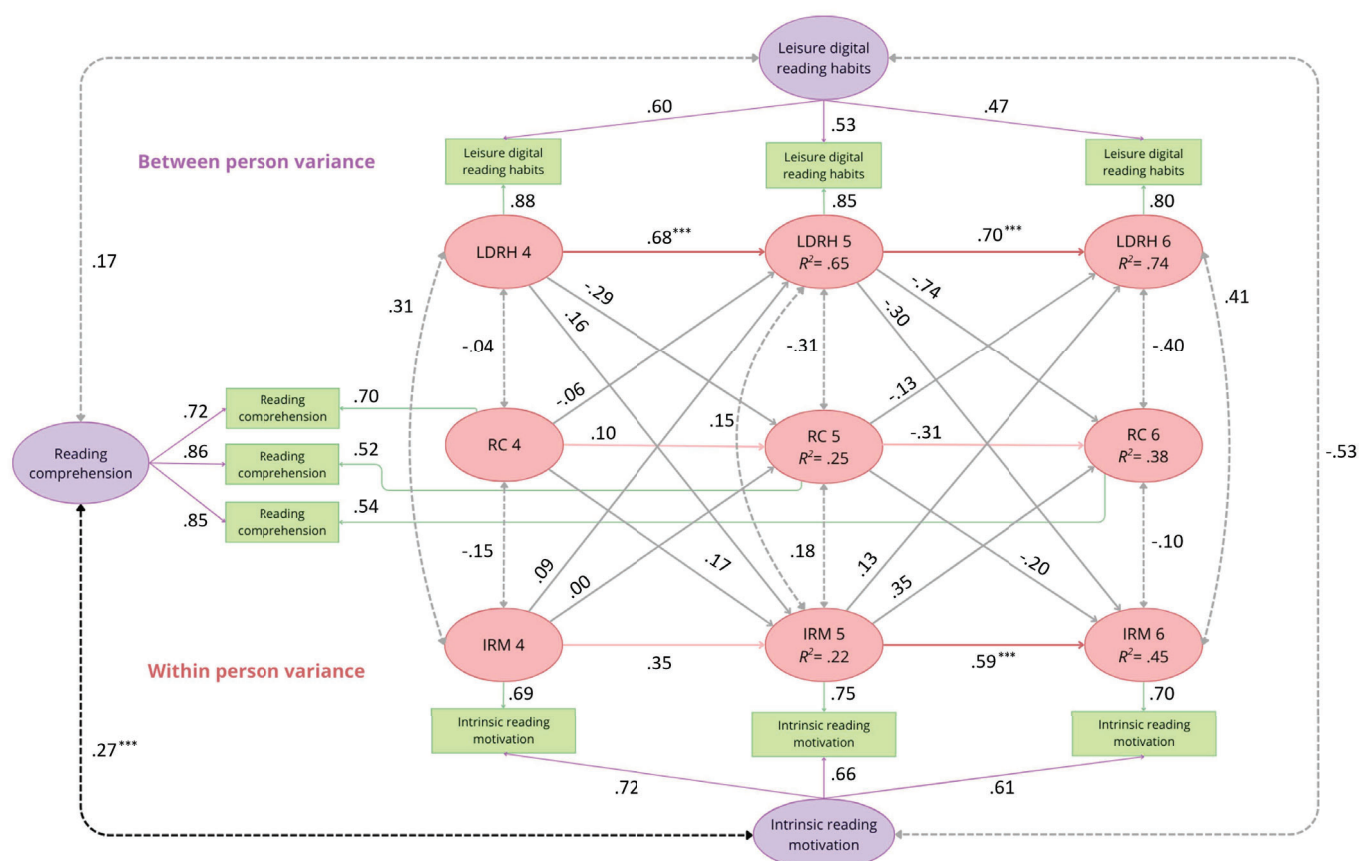
379.08, $p < .001$; $RMSEA = .050$, 90% $CI [.044, .055]$, $CFI = .913$; $SRMR = .057$. As in the CLPM, the χ^2 tests were significant, but this was expected due to sample size sensibility.

Note that in these models, the between-person and within-person variance is separated. That is, the random intercept accounts for stable, trait-like differences between individuals (between-person variance), while the cross-lagged and autoregressive paths reflect fluctuations over time within individuals (within-person variance). This separation is reflected in the smaller proportion of explained variance for each variable at the within-level. In both models, this is evident for reading comprehension (R^2 values between .15 and .38) and intrinsic reading motivation (R^2 values between .22 and .45). By contrast, the proportion of explained variance for digital reading habits did not experience such a substantial detriment, compared to the CLPM (R^2 values between .45 and .74). This is also reflected by the non significance of the between-level variance for digital reading habits in both models. While the between-level variance of reading comprehension and intrinsic reading motivation was significant in both models (reading comprehension: $R^2_{Leisure} = .24$, $p < .001$; $R^2_{Academic} = .24$, $p < .001$; intrinsic reading motivation: $R^2_{Leisure} = .15$, $p < .01$; $R^2_{Academic} = .11$, $p < .01$), it was nonsignificant for digital reading habits ($R^2_{Leisure} = .10$, $p = .35$; $R^2_{Academic} = .04$, $p = .25$). The absence of stable between-person differences in this variable suggests that digital reading habits may fluctuate considerably across time and be more context-dependent than trait-like. Even though this variable has shown to lack significant between-person stability, RI-CLPM allows us to examine within-person longitudinal paths with reading comprehension and intrinsic reading motivation, which have proven to present both stable individual differences and meaningful intraindividual changes over time. In fact, the random intercepts from these two variables were positively correlated, suggesting that students who generally report higher levels of intrinsic reading motivation also tend to have higher overall reading comprehension, regardless of time-specific fluctuations. This association only emerged in the leisure digital reading habits model (error covariance = .27, $p < .001$).

Regarding autoregressive and cross-lagged paths, we observe substantial differences depending on the reading purpose, as well as clear contrasts with the previous CLPM, which treats variance as a single undifferentiated source. Autoregressive effects for intrinsic reading motivation only emerged from grade 5 to grade 6 in both models. This suggests that beyond stable trait-like motivation levels, those students who showed increased motivation in grade 5 (compared to their level in grade 4) will also experience a significant increase in grade 6. By contrast, leisure digital reading habits showed consistent autoregressive effects from grade 4 to grade 5, and from grade 5 to grade 6, implying that if a student read more on digital one year, compared to the previous year, their digital reading habits will also increase the next.

Figure 4.3

Random-intercept cross-lagged panel model for the development of leisure digital reading habits, reading comprehension and intrinsic reading motivation



Note. All paths represent standardized estimates. Dashed lines represent covariances. Control variables were included in the model but are not displayed in the figure for clarity: at the between-level (gender, SEN status, books at home, type of school), and within-level (extrinsic reading motivation, school digital access level. LDRH: Leisure digital reading habits; RC: Reading comprehension, IRM: Intrinsic reading motivation; 4: grade 4; 5: grade 5; 6: grade 6. Significant paths are also indicated with dark arrows to facilitate comprehension. * $p < .05$, ** $p < .01$, *** $p < .001$.

Table 4.5

Control variables standardized estimates from the leisure random-intercept cross-lagged panel model

	Leisure digital reading habits			Reading comprehension			Intrinsic reading motivation		
<i>Time-invariant (between-level)</i>									
Gender	-.30			-.01			-.26***		
SEN	-.02			-.35***			-.15**		
Books at home	-.09			.23***			.21***		
School type	-.03			.15***			.01		
<i>Time-variant (within level)</i>									
	Grade 4	Grade 5	Grade 6	Grade 4	Grade 5	Grade 6	Grade 4	Grade 5	Grade 6
Extrinsic reading motivation	.35***	.23*	.17	-.32***	-.26**	-.08	-.29***	-.21	-.10
School digital access level	.26***	.08	.08	-.11	.01	-.04	-.07	.01	-.05

Note. Gender: 0=Girls, 1=Boys; SEN status: 0= No, 1= Yes; Books at home: 0= 0–10 books, 1=11–25 books, 2= 26–100 books, 3= 101–200 books, and 4= more than 200 books; School type: 0= Public, 1= No-public; School digital access: 0 = The center has computers/laptops/tablets that the class can sometimes use; 1 = The class has computers/laptops/tablets that students can share; 2 = Each student has a computer/laptop/tablet. * $p < .05$, ** $p < .01$, *** $p < .001$.

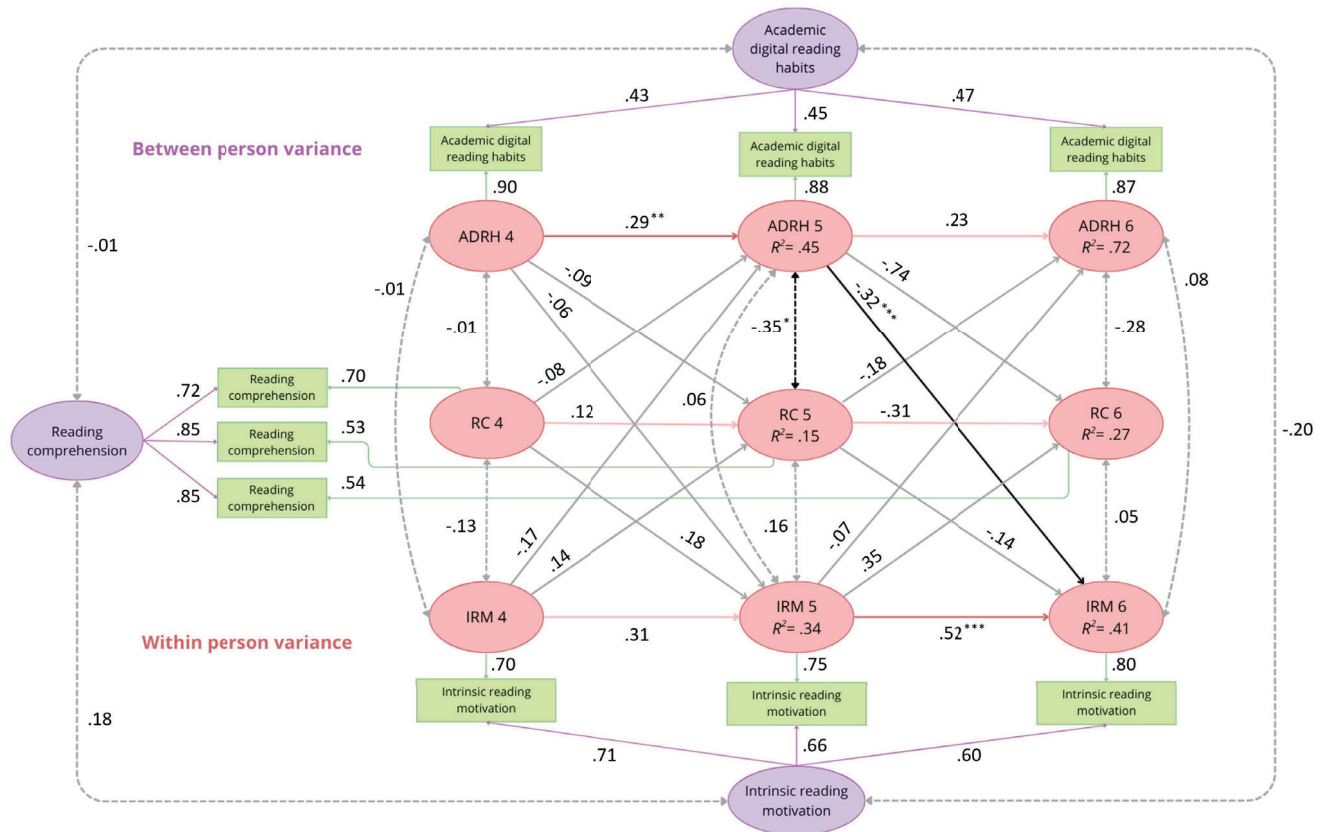
In the academic digital reading habits model, however, autoregressive effects only emerged from grade 4 to grade 5, suggesting that these behaviors may be more susceptible to contextual or

instructional influences in later grades. Notably, no significant autoregressive paths were found for reading comprehension. This means that, once stable between-person differences are accounted for via the random intercept, there is no evidence of temporal carry-over within individuals from one time point to the next. In other words, fluctuations in an individual's reading comprehension at one time point do not predict their fluctuations at the next time point, above and beyond their general tendency to perform at a certain level relative to their peers.

As for cross-lagged paths, no significant effects were found in the leisure digital reading habits model, nor were any significant residual covariances observed between variables. This suggests a lack of systematic within-person predictive relationships. That is, fluctuations in one variable over time do not reliably predict fluctuations in another when comparing students to their own previous scores. Nevertheless, this should not be mistaken for an absence of relationships altogether because the random intercepts for reading comprehension and intrinsic reading motivation were significant and positively correlated. Therefore, while the model shows no evidence of time-specific predictive effects within individuals, it does capture stable between-person associations for reading comprehension and intrinsic reading motivation. By contrast, in the academic digital reading habits model, a significant negative cross-lagged path emerged from academic digital reading habits in grade 5 to intrinsic reading motivation in grade 6. This suggests that if a student read more on digital for academic purposes in grade 5 than in grade 4, their intrinsic motivation would decrease in grade 6. Additionally, a negative residual covariance was observed between academic digital reading habits and reading comprehension in grade 5, indicating that, after controlling for temporal effects, students who engaged more in academic digital reading at that time tended to have lower reading comprehension scores.

Figure 4.4

Random-intercept cross-lagged panel model for the development of academic digital reading habits, reading comprehension and intrinsic reading motivation



Note. All paths represent standardized estimates. Dashed lines represent covariances. Control variables were included in the model but are omitted in the figure for clarity: at the between-level (gender, SEN status, books at home, type of school), and within-level (academic print reading habits, extrinsic reading motivation, school digital access level).

ADRH: Academic digital reading habits; RC: Reading comprehension, IRM: Intrinsic reading motivation; 4: grade 4; 5: grade 5; 6: grade 6. Significant paths are also indicated with dark arrows to facilitate comprehension. * $p < .05$, ** $p < .01$, *** $p < .001$.

Table 4.6

Control variables standardized estimates from the academic random-intercept cross-lagged panel model

	Academic digital reading habits			Reading comprehension			Intrinsic reading motivation		
<i>Time-invariant (between-level)</i>									
Gender	-.10			-.01			-.23***		
SEN	.01			-.36***			-.11*		
Books at home	-.05			.24***			.19***		
School type	.16*			.14***			-.02		
<i>Time-variant (within level)</i>									
	Grade 4	Grade 5	Grade 6	Grade 4	Grade 5	Grade 6	Grade 4	Grade 5	Grade 6
Academic print reading habits	.47***	.32***	.43***	.12	.04	-.08	.54***	.33***	.20**
Extrinsic reading motivation	.36***	.18*	.30***	-.31***	-.25**	-.17	-.29***	-.16	-.11*
School digital access level	.31***	.33***	.44***	-.08	.02	-.03	-.08	.08	-.02

Note. Gender: 0=Girls, 1=Boys; SEN status: 0= No, 1= Yes; Books at home: 0= 0–10 books, 1=11–25 books, 2= 26–100 books, 3= 101–200 books, and 4= more than 200 books; School type: 0= Public, 1= No-public; School digital access: 0 = The center has computers/laptops/tablets that the class can sometimes use; 1 = The class has computers/laptops/tablets that students can share; 2 = Each student has a computer/laptop/tablet. * $p < .05$, ** $p < .01$, *** $p < .001$.

4.4. Discussion

Our study aimed to examine potential causal paths between digital reading habits, intrinsic reading motivation, and reading comprehension across late primary school years. This study makes several novel contributions to the developmental literature. First, it is the first to model the long-term interrelationships between digital reading habits, motivation, and comprehension simultaneously,

providing a more integrated understanding of how these constructs interact over time. Second, by distinguishing between leisure and academic digital reading purposes, we offer a more nuanced perspective on how different forms of digital engagement uniquely relate to children's reading development. Third, by employing cross-lagged panel modelling (CLPM), we were able to estimate long-term directional relationships among digital reading habits, intrinsic motivation, and reading comprehension, allowing for comparisons with prior studies that relied on cross-sectional or standard longitudinal SEM approaches. Building on this, we applied random intercept cross-lagged panel modelling (RI-CLPM), which provides stronger causal approximations by isolating within-person changes over time while accounting for stable between-person differences. This approach allowed us to explore how individual fluctuations in digital reading habits may precede changes in motivation and comprehension, independent of trait-like stability, and vice versa. In addition, our models accounted for a comprehensive set of control variables at student, home and school-level, both time-invariant (gender, SEN status, number of books at home, type of school), and time-variant (print reading habits, extrinsic reading motivation, access to digital devices at school). By including these covariates, we further strengthened the robustness of our findings and reduced the influence of potential confounding factors, particularly those that may otherwise bias within-person estimates. Next, we will discuss our findings and relate to educational implications.

4.4.1. The non-virtuous circle of digital reading

Our results from CLPM indicated initial reciprocal causal paths between reading comprehension and intrinsic reading motivation in both leisure and academic reading models. Specifically, reading comprehension in grade 4 positively predicted intrinsic reading motivation in grade 5, and vice versa. Nevertheless, this bidirectional pattern weakened over time, with only intrinsic reading motivation in grade 5 predicting comprehension in grade 6. Overall, these findings align with prior research using cross-sectional unidirectional designs, or longitudinal studies with limited

measurement points, that support the predictive role of reading motivation over reading comprehension (Orellana-García, 2018; Schiefele et al., 2012). Beyond this type of analyses, by employing RI-CLPM, we were able to disentangle within-person from between-person variance. This allowed us to support that the observed reciprocal paths in the CLPM likely reflected stable trait-based relationships between reading comprehension and intrinsic reading motivation. In our study, the random intercepts of these variables were positively correlated, indicating that individuals who generally exhibited higher intrinsic motivation also tended to have consistently stronger reading comprehension skills across time. Along the lack of significant cross-lagged paths in the RI-CLPM, these results suggest that while moment-to-moment fluctuations in reading motivation and comprehension may not always influence one another symmetrically, there is a stable, enduring connection between the two at the trait level. Importantly, we only observed this significant random intercept correlation when exploring leisure digital reading habits, as this finding was not observed in the model including academic digital reading habits. While the trait-level association did not emerge in the academic model, we argue that it should not be dismissed, since the findings from CLPM support reciprocal paths between reading comprehension and motivation when including leisure or academic reading habits. This discrepancy indicates that different types of reading habits may contribute differently to the distribution of variance. Therefore, we suggest that the trait-level relationship between reading comprehension and motivation likely remains present, but is likely less detectable due to contextual influences on variance structure when introducing academic digital reading habits.

Altogether, the finding that the RI-CLPM for leisure reading revealed a trait-based association between reading comprehension and intrinsic reading motivation offers valuable insight into prior research that conflated between-person and within-person variance by using unidirectional longitudinal designs with limited time-points data (Liao et al., 2022; Soemer & Schiefele, 2018; Stutz et al., 2016; Wang et al., 2020). Notably, the absence of significant cross-

lagged paths at the within-person level challenges the directional assumptions proposed by the "virtuous circle of reading" (Locher & Pfof, 2020; Pfof et al., 2014). This circle suggests that students with strong reading comprehension are initially more motivated to read, leading to increased reading engagement (more frequent reading habits), which in turn strengthens their skills and further boosts motivation. Previous longitudinal studies that have employed traditional structural equation modelling typically have collected information from specific data points that are modelled to test a theoretical direction (Liao et al., 2022; Soemer & Schiefele, 2018; Stutz et al., 2016; Wang et al., 2020). Commonly, this direction follows the virtuous circle of reading, conceiving reading habits as mediators between reading motivation and comprehension. Unlike the present study, these studies employed designs that do not separate between from within-person variance. Our results, based on RI-CLPM, evidence a lack of causal paths from reading motivation to digital reading habits and from digital reading habits to reading comprehension. Therefore, beyond the trait-like relationship between reading comprehension and reading motivation, our findings challenge the idea of a virtuous circle of reading with digital reading habits. Next, we will discuss the findings regarding the specific causal paths between digital reading habits with reading motivation and reading comprehension, addressing other possible directions of causality not described by the virtuous circle of reading.

4.4.2. Digital reading habits and intrinsic reading motivation

After accounting for autoregressive effects and considering only within-person variance, we identified significant causal paths from academic digital reading habits toward later intrinsic motivation, but not the reverse. Specifically, this path indicated that when students reported higher levels of digital reading for academic purposes in grade 5, compared to grade 4, their intrinsic reading motivation tended to decrease by grade 6. Furthermore, we observed that the negative causal path between digital reading habits and intrinsic reading motivation from grade 5 to 6 also

emerged in the CLPM for leisure reading, but did not hold when only accounting for within-person variance in the RI-CLPM. This is a novel finding that contributes to a relatively underexplored area of research, which has largely focused on unidirectional effects from motivation to reading habits (Schiefele et al., 2012).

Overall, our results are in sharp contrast to previous literature that has focused on the role of print reading habits, and digital-based school interventions. Firstly, studies focusing on leisure print-reading habits typically show that they are predicted by intrinsic reading motivation (Schiefele et al., 2012; Soemer & Schiefele, 2018; Stutz et al., 2016; Wang et al., 2020). Studies focusing on the reverse direction are less abundant, but also show positive predictions from print reading habits towards intrinsic reading motivation (Soemer & Schiefele, 2018). The differences with the present findings regarding digital reading habits could emerge due to the shallow reading processing and poor engagement with digital reading materials (Baron et al., 2017; Mangen & Pirhonen, 2022; Mangen & van der Weel, 2016). Unlike print reading, the superficial cognitive processing associated to digital reading environments could prevent students to reflect on the reading materials and enjoy the reading activity in itself (Hakemulder & Mangen, 2024). At the same time, those students that are highly motivated towards reading might be less attracted to such digital materials that do not promote deep engagement or immersive experiences. This idea can be supported by studies that students tend to multitask more when reading on digital devices than on print materials (Romero et al., 2025), reflecting higher concentration and engagement (Baron et al., 2017). In our study, leisure digital reading habits did not predict either an increase or a decrease in intrinsic reading motivation over time. It could be that intrinsic reading motivation does not exert changes in digital reading because they are independent of such reading drive. Although not central in the longitudinal models, the control variables' estimates regarding extrinsic motivation suggest that leisure digital reading habits could be more related to external drives. The instrumentalization of digital reading (e.g., looking for information, communicating with other people) could explain the lack of significant

associations with intrinsic reading motivation, as students do not read digital content for the joy of reading in itself but rather to satisfy a specific need (Ryan & Deci, 2000; 2017). While this in itself is not necessarily negative, it suggests that leisure digital reading should not be mistaken for a substitute for print reading, which previous studies have consistently shown to have reciprocal positive associations with intrinsic motivation (Schiefele et al., 2012; Soemer & Schiefele, 2018; Stutz et al., 2016; Wang et al., 2020).

Secondly, digital-based school interventions have shown overall positive effects on intrinsic reading motivation (Webber et al., 2023). Our results could differ due to the structured guidance that these types of interventions offer. In our study, we controlled for the level of access to digital devices, so that the remaining variance is not influenced by how much children are exposed to digital devices in school. Taking this into account, we observe that, when unsupervised, students digital reading for academic purposes might hinder future intrinsic reading motivation. Additionally, as this type of reading is aimed to fulfil academic demands (e.g., complete homework assignments, study for a test), it is also reasonable to observe a negative effect on intrinsic motivation, which reflects inner pleasure drive. This is supported by previous research that has reported higher reading motivation associations with print reading habits for leisure than for academic purposes (McGeown et al., 2016). Notably, we observed that the path from academic digital reading habits towards intrinsic motivation only emerged when students were in grade 5. This could be related to the accumulative effects of digital reading habits, which presented significant autoregressive effects from grade 4 to 5 grade for academic purposes.

4.4.3. Digital reading habits and reading comprehension

Consistent in both CLPM and RI-CLPM, we did not find significant cross-lagged paths between digital reading habits and reading comprehension. This finding is aligned with metaanalytical evidence that has indicated an overall weak relationship between digital reading habits and

comprehension (Altamura et al., 2025). The longitudinal design of our study enhances the robustness of these previous findings, which have predominantly been supported by cross-sectional or correlational research. Importantly, the RI-CLPM analyses revealed no stable between-person variance in digital reading habits across time for either leisure or academic purposes, indicating that most of the variability in these habits occurred within individuals over time. Even after controlling for relevant student, home, and school level factors (including gender, SEN status, number of books at home, school type, extrinsic reading motivation, and digital access in school) the autoregressive paths remained significant across models. This pattern suggests that increases in digital reading engagement at the individual level are not fully accounted for by reading comprehension.

To explain the lack of reciprocal causal paths between leisure and academic digital reading habits and reading comprehension, we suggest three tentative explanations related to the particular variables included in this study, the measures of digital reading habits, and the increasing integration of technology in children's lives. Firstly, the variety of control variables and the inclusion of a third dependent variable could be explaining digital reading habits variability and their relationship with reading comprehension. To the best of our knowledge, school-level factors such as type of school (public, no public) and the level of digital access in schools have not been considered in studies examining longitudinal causal relationships between reading habits and reading comprehension, whether for print (e.g., Bittman, 2024; van Bergen et al., 2020) or digital reading habits (e.g., Torppa et al., 2020). It is plausible that such school factors moderate the extent to which digital reading habits develop and influence comprehension outcomes. For instance, in the CLPM and RI-CLPM models the school type and school level access to digital devices predicted higher reading comprehension and more frequent academic digital reading habits. Without accounting for these contextual variables, the estimation of the association between digital reading habits and reading comprehension could have been biased. Furthermore, in our study we included reading motivation in our models, a variable absent from previous studies focusing on reading

habits and reading comprehension development employing RI-CLPM (Bittmann, 2024; Erbeli et al., 2020; Torppa et al., 2020; van Bergen et al., 2020). It is possible that some associations reported in previous studies were, at least in part, confounded by unmeasured motivational factors. By explicitly modelling motivation, our study offers a more comprehensive and controlled framework, which may help explain the absence of significant direct effects between digital reading and reading comprehension employing RI-CLPM analyses.

Secondly, our frequency-based approach for measuring digital reading habits may not have captured important qualitative aspects of how students interact and process digital texts. For example, multitasking while reading is more common when reading on digital than on print, which could contribute to a shallow digital reading experience and attentional difficulties (Baumgartner et al., 2017; Larsen et al., 2022). Additionally, short texts, common in digital environments, could also promote shallow reading by preventing readers to develop sustained attention and reading engagement (Wolf, 2018). Such factors could be more directly implicated in the hindering of reading processes described by the digital chain hypothesis, and further studies could explore these qualitative aspects over time. Overall, our study represents an initial step toward understanding how digital reading habits interact with children's reading development.

Thirdly, digital reading habits may be developing increasingly independently of reading comprehension due to broader sociocultural influences. Previous studies employing RI-CLPM and focusing on digital reading habits and reading comprehension have reported both positive and negative cross-lagged associations between these variables (Torppa et al., 2020). Beyond the inclusion of motivation and relevant control variables in our models, as discussed earlier, another critical factor that may account for the divergence in findings is the difference in cohort characteristics. Specifically, the cohort in Torppa et al.'s (2020) study was born in 2000, whereas the participants in our study were born in 2012 (or late 2011). This twelve-year gap likely reflects substantial shifts in the digital landscape, including the increasing ubiquity, accessibility, and

normalization of digital technologies in both educational and leisure contexts (Merga & Roni, 2017; Twenge et al., 2019).

4.4.4. Limitations

This study has several limitations that should be considered when interpreting the present findings. First, all the students in the sample were from the same region, which may have introduced similarities in school curricula and activities, including homework loads. We attempted to address this issue by recruiting students from a variety of schools. While we attempted to control for school-level clustering in both the CLPM and RI-CLPM, we encountered convergence issues that prevented successful model estimation. As a result, we chose not to include clustering in the final models. Nevertheless, to account for potential school-level influences, we included key school-related control variables that could plausibly explain clustering effects (school type and school-level access to digital devices). To assess the impact of these controls, we examined how the intra-class correlation coefficient (ICC) for school clustering changed when these variables were included. We found that the ICC dropped to an average of 0.05, suggesting that a substantial portion of the between-school variance was accounted for by these covariates (Hox et al., 2017). Both the analyses with the attempts of controlling for cluster and the ICC assessment are provided in Table C5 in Appendix C. Future research would benefit from including participants from other countries to compare the present results, and from more schools that can guarantee model convergence. Second, the number of participants varied slightly across the three measurement points, a common challenge in longitudinal studies (Enders, 2010). This is a limitation that must be accepted, and researchers must adopt adequate statistical methods to deal with missing data in their analysis (Enders, 2010). In our case, we used FIML which is indicated for missing data at random (Xiao & Bulut, 2020). Third, we relied on self-report questionnaires to assess reading habits and motivation. Despite being a cost-effective method widely used in the literature, participants' responses may

have been influenced by personal and social biases (Locher & Philipp, 2023). Future studies could complement self-reports with additional data sources, such as parent or teacher reports, to provide a more comprehensive perspective. Notably, we acknowledge that the print reading habits scales exhibited poor internal consistency. Although these measures were used solely as control variables, this represents an important limitation of the study. This issue partly reflects our decision to adopt a broad approach to assessing habitual reading, aiming to capture the diversity of students' real-world reading behaviors. We also recognize the value of examining each item individually, as specific reading activities (within the same reading media) may relate differently to reading motivation and reading comprehension. To enhance transparency, we provide a correlation matrix of all individual print and digital reading habit items with the key study variables in Appendix C (Table C4). Nevertheless, the overarching aim of this study was to reflect students' authentic and varied reading experiences, which is why we kept the aggregated scores. While the psychometric limitations of the print reading habits scales should be acknowledged, the internal consistency of the digital reading habits scales, which were central in our models, was acceptable for their four-item structure. Shorter scales are generally more sensitive to internal inconsistencies than those with a larger number of items (Netemeyer et al., 2003). This has a related limitation: including more items can sometimes be counterproductive, particularly for younger respondents. Increased questionnaire length may lead to fatigue and disengagement, potentially resulting in more biased responses. Given that our study involved primary school students, it was essential to strike a balance between item specificity and overall questionnaire length (Altamura et al., in press). Furthermore, by controlling for measurement error, we strengthened the validity of our findings. Taken together, these decisions support a broad, ecological approach to understanding the reading behaviors of primary school students. Finally, our measure of reading comprehension was limited to a paper-and-pencil test. Including alternative assessments, such as tasks measuring online reading

comprehension or tests conducted on digital devices, could provide valuable insights into how different reading habits influence comprehension across formats.

4.5. Conclusion

For decades, developmental research has consistently highlighted the importance of exposing children to print reading as a way to foster reading comprehension and reading motivation (Allington & McGill-Franzen, 2021; Mol & Bus, 2011, Schiefele et al., 2012). As reading habits are changing worldwide due to increased digitization of children's lives, the processes underlying the development of those relevant skills could be also changing (Wolf, 2018). Our study supports the absence of reciprocal causal effects from digital reading habits to later reading comprehension, while also revealing a detrimental effect on later intrinsic reading motivation when reading digitally for academic purposes.

Regarding educational implications, parents and educators should be cautious when promoting unstructured digital reading during early developmental stages. While digital tools may be intended to encourage reading interest, they could inadvertently diminish the inherent pleasure of the activity. Future research in education could investigate strategies to foster intrinsic motivation in students when engaging in autonomous digital reading. With digital devices becoming an integral part of daily life, it is essential to establish a research agenda to monitor the long-term effects of digitization on cognitive and affective aspects critical to children's development. Our study takes a foundational step in this direction.

Online supplementary materials

Online supplementary materials can be freely accessed at

https://osf.io/umbcr/?view_only=5e62ea68f2c945fa839780adb9d7f48d

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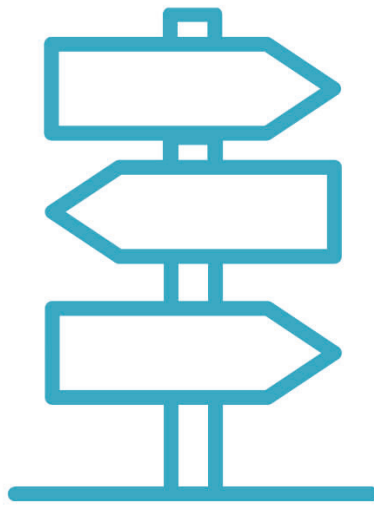
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Chapter V



Discussion

Chapter V

Discussion

This dissertation has examined new reading habits and their relationship with reading comprehension, with a particular focus on digital reading habits. It pursued two main objectives: first, to investigate the relationship between digital reading habits and reading comprehension through a review of the existing literature; and second, to explore the longitudinal associations among digital reading habits, reading comprehension, and reading motivation in Spanish primary school students. This final chapter provides an integrated summary of the key findings drawn from the three studies included in the dissertation. It concludes with a discussion of the broader educational implications of the findings and proposes potential directions for future research.

5.1. Key findings

The first two studies of this dissertation suggest that digital reading habits and reading comprehension have a weak relationship overall, negative in the case of primary school students. Furthermore, when considering longitudinal evidence, in Study 3, we find that digital reading habits and reading comprehension do not predict one another over time in this educational stage. Next, we will highlight how the included studies support these findings and how they complement one another.

First, in Study 1, we carried out the first meta-analysis to date that examined the relationship between leisure digital reading habits and reading comprehension. This meta-analysis gathered information from different studies that assessed readers from different age groups and different countries. This study sought to fulfil the first objective of the present dissertation. We found that the overall relationship between leisure digital reading habits and reading comprehension across the

available literature was small and positive, but almost null. Despite the small average effect size, we identified negative associations at early educational stages (i.e., elementary and middle-school), while positive at later stages (i.e., secondary school and university students). Facing such small average sizes and the negative direction in early educational stages, we concluded that, overall, digital reading habits do not pay off as much as print reading has historically reported (Allington & McGill-Franzen, 2021; Mol & Bus, 2011). This idea was further supported by the cross-sectional results from Study 2, in which we developed the Multidimensional Reading Habits Instrument. This instrument was designed to measure both digital and print reading habits for leisure and academic purposes in primary school students from grade 4 to 6. The correlational analyses showed positive relationships between print reading habits and reading comprehension, while negative for digital reading habits. The reason of such weak negative associations between digital reading habits and reading comprehension might be partially explained by the digital chain hypothesis (Wolf, 2018). According to this hypothesis, habitual engagement with short, non-linear, ephemeral digital content can promote the development of a shallow mindset, which prevents deep reading processes, and thus, from adequate comprehension. Nevertheless, this hypothesis is grounded on over-time effects. To explore and nuance the associations described in Study 1 and 2, Study 3 presented a longitudinal study focusing on primary school students. This study aimed to explore the directionality and causal paths of digital reading habits with reading comprehension and intrinsic motivation, following the second objective of this dissertation. In this study, we analyzed data from students from grade 4 to 6 (three consecutive years). Essentially, the cross-paths did not reveal any significant relationship between digital reading habits and reading comprehension over time, either for leisure or academic purposes. This finding provided no support for long-term effects of digital reading habits on reading comprehension, as suggested by the digital chain hypothesis (Wolf, 2018). Altogether, this longitudinal evidence supported the almost null average effect size found in the meta-analysis

(Study 1) and differed from the significant negative correlation from the cross-sectional analysis shown in Study 2.

Additionally, reading motivation is considered as a relevant variable that had been strongly related to print reading habits and reading comprehension in previous research (Orellana-García et al., 2018; Schiefele et al., 2012). For this reason, in Study 2 reading motivation was measured and employed to determine test-criterion validity evidence for the MRHI. In line with the scarce literature that had studied such relationships (e.g., McGeown et al., 2016), we found that intrinsic reading motivation presented negative correlations with digital reading habits in Study 2. In Study 3 we also introduced reading motivation in order to help explain the underlying mechanism between digital reading habits and reading comprehension relationships in primary school students. When examining longitudinal associations, we found that digital reading habits negatively predicted intrinsic reading motivation, whether for leisure or academic purposes. Of note is that only academic digital reading habits presented within significant cross-path effects from grade 5 to 6. As mentioned in the discussion of Study 3, this difference may be partly explained by the control variables introduced and the possibility that reading out of obligation, rather than personal inner drive, might not be conducive to fostering intrinsic reading pleasure.

By employing different statistical methods, these studies point out to an overall non-existent association between digital reading habits and reading comprehension. Therefore, our results do not support the digital reading chain hypothesis, at least among primary school students. It is important to emphasize that this finding holds true for both leisure and academic reading purposes. Along such null effects, our studies support negative effects from digital reading habits to intrinsic reading motivation. Altogether, these results contrast with previous evidence regarding print reading habits. Commonly, reading comprehension, reading motivation, and reading habits describe a virtuous reading circle in which these variables reinforce one another in a positive feedback loop

(Locher & Pfof, 2020; Pfof et al., 2014). Following this logic, our results support a rather non-virtuous circle of digital reading.

Given the exploratory nature of this dissertation, we cannot provide a definitive explanation for the observed non-virtuous cycle of digital reading. Nevertheless, we consider our findings to represent important first steps toward understanding how contemporary digital reading habits relate to reading comprehension. Next, we discuss educational and methodological implications based on these results.

5.2. Educational implications

Overall, the findings of this dissertation suggest that while digital reading habits do not have a clearly negative impact on reading comprehension development, they are not particularly beneficial either. Our results focus specifically on primary school students, who are still in the process of acquiring and consolidating key reading skills. Compared to older learners, this group may be more susceptible to influences that do not actively support their reading development. We would like to highlight two key educational implications: first, the use of digital devices on reading comprehension development; and second, how to use digital formats to foster students' reading motivation.

5.2.1. The use of digital devices on reading comprehension development

Digital reading is a part of our daily lives, and students will need to master how to read in digital environments as well, beyond print reading. That is why we do not recommend taking digital reading away from students' education. What we advocate is that to be able to contribute to their reading comprehension development, digital reading must serve as a complementary reading tool, without necessarily substituting print reading (E-READ, 2019). How can we integrate and promote digital reading habits in a complementary way to print reading? First of all, we need to be aware of

how digital reading can help students. One of its strengths, inherently different from printed texts, is the access to information. Students might benefit from activities that require looking for information on the internet to answer a given query, such as research projects (Salmerón et al., 2023), while they still practice comprehension sub-skills (e.g., vocabulary and grammar) in print. Although this dissertation focuses on out-of-school reading habits, we believe schools can play a critical role in promoting responsible and enriching digital reading practices, and in fostering their transfer beyond the classroom. As we have highlighted numerous times, print reading habits have shown positive relationships with reading comprehension development (Allington & McGill-Franzen, 2021; Mol & Bus, 2011), especially at early educational stages (Locher & Pfof, 2020). The reasons for such benefits might be related to the acquisition of language knowledge and the improved capacity to concentrate and reflect on the information (see section 3 of Chapter 1). Unlike print texts, digital texts are immediately accessible with just connecting to the internet, an undeniable advantage of digital reading. Nevertheless, the ease of access is often accompanied by a lack of quality control. Online content is frequently written in informal, conversational language, which may not support the development of more advanced reading skills (van Moort et al., 2015; Snow, 2010). Furthermore, because digital content tends to favour brevity, when students navigate the internet unsupervised, they can be more frequently exposed to short or poor-quality texts, with fewer opportunities for deep engagement or thoughtful reflection (Wolf, 2018).

To address these challenges, students could benefit from explicit, structured guidance on how to identify and engage with high-quality digital reading materials. One key instructional focus should be teaching students how to locate quality texts online. This involves cultivating a set of digital reading sub-skills, including the ability to navigate digital environments, critically evaluate sources, and appropriately integrate the contents (Salmerón et al., 2018; van Moort, 2025). These are not intuitive abilities, especially for younger learners, and we must avoid assuming they already possess them. If we do, we risk perpetuating the myth of the "digital native" (Prensky, 2001, 2009),

the mistaken belief that children raised in a digital world inherently know how to use technology wisely and effectively. In reality, while today's students may be fluent in using devices and apps, they often lack the deeper cognitive and critical skills required for meaningful engagement with digital texts (Kirschner & De Bruyckere, 2017). Beyond teaching students how to identify high-quality materials, teachers can also offer curated websites that minimize digital distractions and feature a variety of topic-specific digital texts, such as online libraries. In the Spanish context, Intralíneas, for example, is a free digital platform with reading materials from different genres and oriented to specific grades (Intralíneas, n.d.). Scaffolding young students in supervised digital environments might help counteract the shallow mindset fostered by the common contents and displays of digital reading.

5.2.2. How to use digital formats to foster students' reading motivation?

Another important aspect we wish to highlight is the limited opportunity for reflective, deep reading when engaging with digital texts, which might contribute to a diminished intrinsic reading motivation. As we have determined through Study 2 and 3 (Chapters 3 and 4), digital reading habits have a negative effect on intrinsic reading motivation. We argue that there could be a potential influential factor concerning the multifunctional role of digital devices in modern life. Today's smartphones and tablets are designed for a wide range of purposes: from making calls and taking photos to listening to music and, of course, reading. "It is only a few years ago that connecting to the Internet, using online media, and communicating with others via technology were actions that required conscious planning, mental effort, and specific arrangements, such as sitting down in front of a computer." (Reinecke et al., 2018, p.1). Nowadays, almost everyone carries these handheld devices everywhere, and it is reasonable to assume that some reading occurs in their usage. Nevertheless, the *quality* of this reading tends to differ greatly from that of print. Whereas print reading invites focused engagement by demanding time and mental space, digital reading is often

incidental and conducted “on the go”, specially for leisure purposes. Readers might search for practical information out of curiosity, but once the question is answered, the reading ends abruptly. Standing in line or walking down the street, it is common to see people on their devices, though their attention is fragmented. In such moments, reading becomes a secondary, often unconscious and automatic activity (Chen et al., 2020; LaRose, 2010), a distraction rather than a deliberate act. Hakemulder and Mangen (2024) refer to hedonic and eudaimonic responses when reading. Hedonic responses would be related to these short-instant gratification moments, while eudaimonic responses would relate to long-term effects through meaningful connections and reflections from the text. Of course, people can also casually flip through printed texts as a short-term entertainment activity, but unlike digital devices, people do not carry printed materials with them at all times. Furthermore, because the content on digital devices is short and non-linear, it invites short-interactions in which sustained attention is not strictly needed, nor fostered (Carr, 2010; Wolf, 2018). Some concerns are related to the persistent urge to be “online vigilant”, that is, the predisposition to frequently check or react to any type of notification from our digital devices (Reinecke et al., 2018). The need to be constantly available on the digital sphere can contribute to problematic internet behaviours (e.g. addiction, procrastination), psychological and emotional problems (e.g., stress, anxiety, depression) (for a review see Busch & McCarthy, 2021).

Since digital devices have become such indispensable companions and serve so many functions, they are not necessarily perceived as tools primarily intended for long reading. Commonly, students still prefer print reading to this end (Baron et al., 2017; Mizrachi et al., 2018, 2021). This perception could lower expectations and engagement when reading on screens. As Wolf (2018) indicates, such expectations and shallow mindset can be transferred to other types of reading, for example, when readers are required to engage with long texts, either in print or digital format. One exception can be applied to e-readers, digital devices created exclusively to read. Nevertheless, they represent only a specific off-line digital reading activity, and they still present characteristics

of digital interfaces, such as lack of spatiotemporal markers (Mangen et al., 2012), which can prevent deep engagement as well.

To change the shallow mindset associated with digital reading, educators could intentionally incorporate reading time with high-quality digital materials into the classroom setting, helping students form deeper connections with digital texts (McDonald et al., 2022). In the Spanish context, a recent guide to promote reading at schools involves the combination of print and digital reading media. For example, it includes trips to the school or local library, creating digital texts and contents and sharing them with their peers, forming reading clubs... (Fundación Germán Sánchez Ruipérez & López Royo, 2024). Taking advantage of the instant access of information, as previously suggested, educators can promote individual interest by asking students to formulate a research question of their choice and investigate it (Springer et al., 2017). To support focused digital reading, students could benefit in learning how to reduce distractions, such as enabling ad blockers or disabling notifications (Biedermann et al., 2021). By promoting slower-paced online reading experiences and reducing reliance on instant gratification, we could reshape the common shallow engagement associated with digital reading texts.

5.3. Methodological implications

We would like to conclude the implications section by highlighting the importance of the statistical approach when studying relationships between digital reading habits and reading comprehension. Specifically, we draw attention to two key points. First, the comparison between correlational and cross-sectional designs; and second, the distinction between between-person and within-person variance in longitudinal analyses.

5.3.1. Cross-sectional or longitudinal: what does time tell us?

Firstly, as we have seen, Study 1 collected data from different studies supporting an almost null relationship between digital reading habits and reading comprehension. The findings from Study 2, also cross-sectional and correlational, supported negative relationships in primary school students. The negative direction was aligned by what the moderator analysis of the meta-analysis evidenced for primary school students: a small negative association. Nevertheless, the longitudinal study helped to clarify if there were some possible causal paths. By considering autoregressive effects and a series of control variables, the longitudinal study gave support to the existence of a null relation between digital reading habits and reading comprehension.

According to these results, we observe that the choice between cross-sectional and longitudinal designs carries important implications for how relationships between variables are interpreted. Cross-sectional designs, as used in Studies 1 and 2, capture associations between variables at a single point in time. Statistically, this means they rely solely on between-subject variance, without any indication of temporal order or causal direction (Johnson, 2010; Robinson et al., 2005). For example, observing that students who report more frequent digital reading tend to show lower reading comprehension does not allow us to determine whether digital reading leads to lower comprehension, whether students with lower comprehension prefer digital formats, or whether both are influenced by a third variable, such as reading motivation in our case. In contrast, longitudinal designs, such as the one employed in Study 3, offer a framework to examine potential reciprocal influences over time. By incorporating autoregressive paths (i.e., the effect of a variable on itself across time) and cross-lagged paths (i.e., the effect of one variable at Time 1 on another variable at Time 2), help determine whether earlier levels of digital reading habits predict changes in reading comprehension, and vice versa (Johnson, 2010; Robinson et al., 2005).

5.3.2. Individual fluctuations or group differences in longitudinal studies?

Secondly, within longitudinal analyses, we also find different approaches that can yield different results. As we have explained in Study 3, the CLPM captures longitudinal associations but cannot support causal claims, as it estimates temporal associations between variables by combining all observed variance (Hamaker et al., 2015; Usami, 2021). This includes both stable, trait-like differences between individuals and temporary, situational fluctuations. To overcome this limitation, the RI-CLPM separates these two sources of variance by including latent random intercepts for each variable (Hamaker et al., 2015; Usami, 2021). These intercepts capture between-person variance, representing individual tendencies that remain stable over time. The cross-lagged paths in RI-CLPM are then estimated exclusively at the within-person level. This distinction proved crucial in our dissertation objectives and could help to understand previous literature findings as well. Specifically, in the extensive tradition of reading comprehension and reading motivation literature, this was the first study, to the best of our knowledge, that applied RI-CLPM. Therefore, we cannot rule out the possibility that previous studies have confounded between-person and within-person effects, potentially overestimating the dynamic interplay between these constructs (Curran & Bauer, 2011; Orth et al., 2021). With this reflection, we emphasize the importance of considering diverse methodological and statistical approaches, complementing each other, to further understand a determined association.

5.4. Future research lines

This doctoral dissertation has opened new avenues of research that merit further exploration. In particular, we identify four lines of research, related to reading comprehension and reading habits.

5.4.1. Reading comprehension in the future digital landscape

One important avenue of future research is the exploration of reading habits in relation with digital reading comprehension. In the present dissertation, the focus was mostly on the offline reading comprehension conceptualization (in print). In Studies 2 and 3 (Chapters 3 and 4), we employed a standardized reading comprehension instrument that assessed key reading dimensions, such as understanding at the textual level, making inferences, and evaluating content, but was limited to offline reading comprehension. All students completed the assessments using paper-and-pencil formats. As a result, we cannot rule out the possibility that students' digital reading habits and their digital reading comprehension may differ in meaningful ways from what was captured in our studies. Among the studies included in the meta-analyses, no significant differences were observed based on the medium used to assess reading comprehension. Nevertheless, it is important to note that the vast majority of these studies also relied on paper-based assessments. Future research should therefore adopt a broader perspective, investigating how print and digital reading habits relate differently to (offline) reading comprehension, whether assessed in print or digital format, or to online digital reading comprehension, which involves additional processes such as navigation, evaluation, and the integration of multiple sources. Such type of studies are present mostly in correlational and cross-sectional studies (e.g., Kanninen et al., 2022; Naumann, 2015). Nevertheless, to date, no longitudinal study has addressed the relationship between reading habits and digital reading comprehension over time.

Furthermore, as noted in Chapter 1, section 2.2, digital reading comprehension is a dynamic construct that continues to evolve alongside technological innovation. For instance, contemporary scenario-based assessments now require students to consult multiple sources, search for information via web browsers, and evaluate the credibility of online content (Sabatini et al., 2019). Nevertheless, as technology and its educational applications advance, assessment formats will likely evolve as

well. In the near future, students may rely less on manual navigation and integration of information across multiple documents, as artificial intelligence systems increasingly take on tasks such as summarizing, filtering, or even interpreting information. In such contexts, new skill demands may emerge, notably, the ability to critically evaluate AI-generated content, verify sources, and maintain an active, reflective stance when interacting with automated tools (Bauer et al., 2025). We must consider that as technology and its interfaces continue to evolve, they will enable new functions and will have different physical characteristics. Such features may shape emerging reading habits and redefine our understanding of reading comprehension. For example, touch tables and projectors systems could be further developed in the future, bringing to life scenarios we now only see in science fiction films. Touch tables are “interactive horizontal displays that enable multiple users to simultaneously interact with content presented on a table” (Creed et al., 2013, p. 68). These large devices allow displaying multiple documents simultaneously, combining the characteristics of regular electronic tablets and the possibility of arranging the digital documents around the table space, similar to print materials (Leroy et al., 2020). Other interactive systems that allow for better spatial organization than regular tablets or computers are touch-projectors. Instead of a big-screen interface, in this case, a projector is displayed on a flat surface, with sensors or cameras that detect the human touch interaction (Schmittchen & Avdullahu, 2020). Touch-tables and projectors have been in the market for more than three decades, predominantly oriented towards learners' collaboration (see for example Lee et al., 1985). Such systems could potentially be further developed in the future, optimizing their use in everyday classrooms or even at home, further reshaping components of reading comprehension.

5.4.2. Future reading habits measurement

As we explained in section 2.1 (Chapter I), technological innovations influence what people read in their daily lives. As with reading comprehension in the digital landscape, it is necessary to keep

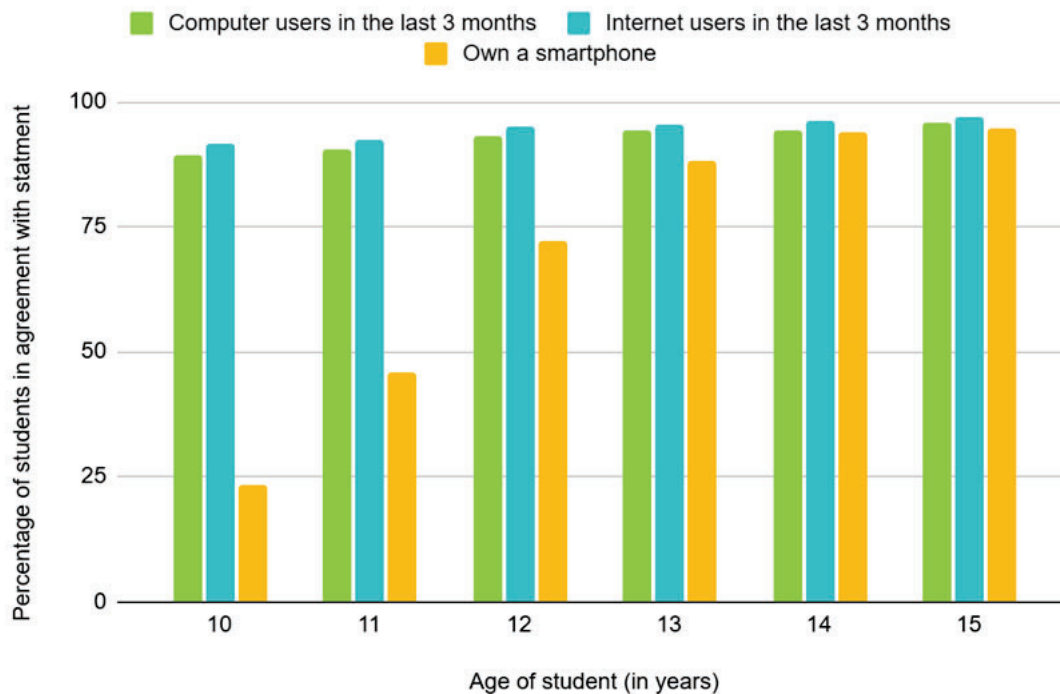
reading habits measurements updated. We highlight this need especially regarding digital reading habits, as the content and format of these habits are in constant evolution. In the present dissertation, we have measured reading habits in terms of frequency, asking students how much they read a selected concise list of digital reading contents. There are other measurements that aim to be more precise in the type of contents that are read. One representative example is the website recognition instrument. Similar to the common author recognition test (see Study 2, Chapter 3), this test aims to capture how familiar the reader is to certain websites. For example, Strømsø (2024) developed a web-recognition test (WRT) in which students are instructed to decide if a determined website is real or not. The websites can refer to lifestyle topics, news and culture; and social activity. This instrument has been tested in Norwegian university students, proving to have null associations with reading comprehension (offline) (Strømsø, 2024), similar to the results of Study 1 (Chapter 2). In a later study, Bråten et al. (2025) included control variables such as word recognition and reading attitudes, showing that news and culture website recognition positively predicted reading comprehension. This instrument could be adapted to secondary school students, to further explore what type of contents young readers are engaging with.

Additionally, we emphasize that future research regarding digital reading habits should explore more in depth the transition stage between primary and secondary school. One possible explanation regarding the non-significant longitudinal associations between digital reading habits and reading comprehension in Study 3 could be related to the extension of the study. Prior research by Torppa et al. (2020) reported mixed evidence for causal paths in Finnish students. Particularly, they found a positive within-person effect from digital reading habits in grade 3 to reading comprehension in grade 4, and a negative effect from grade 6 to grade 7. This divergence in findings with Study 3 may suggest that the hypothesized shallow reading mindset, described by the digital chain hypothesis (Wolf, 2018), could require a longer period of habitual digital reading to produce measurable cumulative effects. Considering that Torppa et al. (2020) evidenced negative causal

paths from grade 6 to 7, maybe an extension of our longitudinal study could have yielded similar results in later grades. It is possible that as students grow older, their digital reading habits and familiarity with technology also increase. In Spain, this is reflected in the increasing ownership of a smartphone and increasing accessibility to computers and internet. Figure 5.1 presents national data regarding these rates. Especially by age 12, the rates of smartphone ownership start to rise (72.1%) until age 15, by which almost all students have their own smartphone (94.8%). In Study 3, we observed a year-by-year increase in digital reading habits. It is likely that this trend continues into secondary school, as shown by PISA data (Chapter 1, section 2.1.1), favouring the emergence of cumulative effects.

Figure 5.1

Percentage of smartphone ownership, and computer and internet usage in Spanish students



Note. Graph elaborated from INE (2023) data. Retrieved from

<https://www.ine.es/jaxi/Tabla.htm?tpx=60814&L=0>

Another important consideration in reading habits is related to the interaction between the reader and the content. As we highlighted in the educational implications (Section 5.2.2), there are some concerns about deliberated reading nowadays. Print reading typically requires sustained, focused engagement over extended periods, whereas digital reading often encourages brief and fragmented interactions. While some readers may allocate dedicated time and attention to reading long-form digital content (i.e., e-books, scientific reports, news on electronic journals...), others may engage with similar materials in more casual or distracted ways, for instance, while waiting in lines, commuting short distances, or multitasking with television. In these last scenarios, the attention is not mainly devoted to reading and there is not too much room to reflect on what has been read. Furthermore, the content, that tends to be short in nature, does not favour such reflection and deep understanding (Annisette & Lafrancière, 2017; Carr, 2010, Wolf, 2018). Future research could go beyond the reading frequency and explore how the reader engages with the text: which content, where, when, for how long... This research would benefit from objective measurements such as log-data in electronic devices (e.g., Locher et al., 2023; Parry et al., 2021; Vuorinen et al., 2024), qualitative measurements such as observational techniques (e.g., Blikstad-Balas & Klette, 2020), or process-based measurements such as eye-tracking instruments. For the latest, technology nowadays allows to track eye-movements in both, print and digital devices. Eye-tracking glasses are portable-eye-tracking systems that allow for more ecological validity than embedded computer eye-trackers, and can be used to measure eye-movements beyond reading on a screen (Mele & Federici, 2012). Particularly, they can be useful to measure print reading. Nevertheless, they might be uncomfortable if worn too much time, and an experimenter should supervise its use. Future technical innovations involve smart glasses, like the Ray-Ban smart glasses, in collaboration with Meta (Waisberg et al., 2024). These look like conventional glasses but count with digital features that project on the glass. Google also launched their own glasses around 2014, but they were pulled from the market a year later, mainly due to their high cost (Weidner, 2024). Eye-tracking for digital

reading has continued evolving. Some emergent research points to the integrated cameras of smartphones and tablets as a tool to track eye-movements (Cheng et al., 2022; Holland & Komogortsev, 2012). By capturing how the reader interacts with the reading content (and its characteristics, such as visual display and length), we will be able to delve deeper into how current reading habits are influencing reading processes in the long run.

5.4.3. Micro-level context influences: school and home environment

In this dissertation we have focused mainly on the reader development, taking into consideration some environmental variables such as the level of school digitalization, type of school, and number of books students have at home. More research into school and home environment should be promoted to understand differences in reading habits acquisition and reading comprehension development. Focusing in such micro-level influences (PCCT, Bronfenbrenner & Morris, 1998, 2007), for example, teachers' reading habits (in print) have demonstrated to have positive influences on students' reading habits, mainly due to increased reading instruction (Applegate & Applegate, 2004; McKool & Gespass, 2009). Similarly, parents' reading involvement at home (e.g., parents' reading frequency, shared reading frequency), along their socioeconomic status, also play a significative role on promoting children reading habits (Jabbar et al., 2021; McGeown et al., 2016; Stutz et al., 2016). Along with increased reading frequency, parental reading involvement and socioeconomic status also influence positively on children's reading comprehension level (Claes et al., 2024; Davis-Kean, 2005; Yu et al., 2025). As for digital reading, studies show that teachers' digital training is positively related to students' reading comprehension (Salmerón et al., 2023) and digital literacy (Lorenz et al., 2019). Nevertheless, less is known of how students' reading habits (either in print or in digital format) are influenced by teachers' digital training and digital reading instruction. Regarding home influences, some studies have focused on parent-shared reading with electronic books. A metaanalytical study indicates that electronic features on e-books negatively

influence on dialogic reading and children's story comprehension, mainly due to distraction effects (Furenes et al., 2021). Regarding home socioeconomic status, scarce literature is found. Studies such as the one of McGeown et al. (2016) showed that socioeconomic status negatively predicted digital reading habits on primary school students. These micro-environmental influences require further investigation, as school and home literacy are crucial to shape young readers' habits and comprehension skills. As digital devices continue to evolve and integrate into people's lives, the way teachers and parents use them will also change, shaping children's practices and development. For example, just as we have evidenced a decreased reading frequency in print in children and adolescents, parents' reading practices have also experienced changes lately. For example, a survey carried out by NielsenIQ BookData from more than one thousand parents in the United Kingdom showed that only 41% of children aged 0–4 are read to regularly, down from 64% in 2012 (HarperCollins, 2025). Some studies warn about parents' use of smartphone and a diminishing feeling of connection and language development of their children (Kushlev & Dunn, 2018; Morris et al., 2022). This emergent evidence calls for more research on children's immediate environments.

5.4.4. Macro-level context influences: educational stages and cultural differences

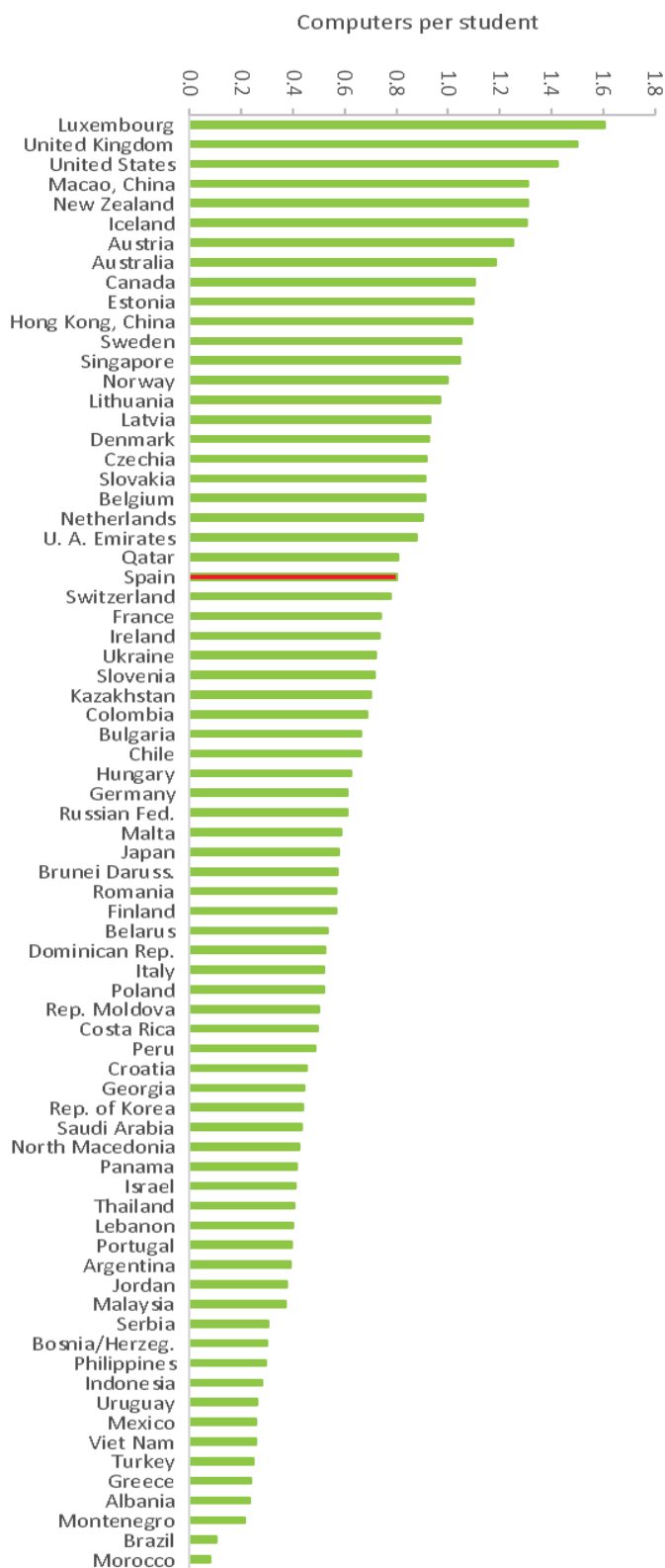
Lastly, future research could focus on the differences across age groups or educational stages regarding digital reading habits influences, dimensions that belong to the macro-level environment (PCCT, Bronfenbrenner & Morris, 1998, 2007). In our meta-analysis, we observed that most studies tend to focus on a single educational stage (e.g., primary school, secondary school, or university level). While comparing findings from such studies is valuable, data drawn from the same study across multiple educational levels would allow for more meaningful comparisons. The advantage lies in the fact that all data would be collected at the same point in time (i.e., the same macro-time), making it more sensitive to the technological processes and trends of that particular period. Furthermore, using the same, or at least similar, instruments across groups would strengthen

the robustness of the comparisons, as it would reduce variability due to methodological differences and enhance the internal validity of cross-level inferences. Following this idea, we have studied how media multitasking reading habits (MMRH) were related to reading comprehension in two groups of university students and one group of secondary school students (Romero et al. (2025). The data was collected between 2021 and 2022, tapping into the same macro-time. They used instruments that were similar to each other, adapted in complexity and contents for each educational stage. The results showed that in neither of the university students groups, MMRH were significantly correlated to their reading comprehension level. Notably, this relationship was negative and significant for the group of secondary school students. Even though our study did not include digital reading habits, multitasking while reading represents a qualitative aspect of reading habits. Particularly, multitasking has been more frequent when reading in digital than when reading in print (Baron et al., 2017; Romero et al., 2025; Subrahmanyam et al., 2013). Future studies could adopt this inter-educational-level approach to better compare such relationships and provide adequate guidance to students at different educational levels.

Similarly, cross-cultural studies could shed light on how reading habits are related to reading comprehension and reading motivation development in different countries. This line of research will tap into macro-system differences by comparing different cultural backgrounds. For example, such differences could be reflected in the level of school digitalization. As shown in Figure 5.2, the number of computers available to students at school varies widely across countries. In Spain, there are fewer than one computer per student (0.80), while Norway (1.00) ensures individual access, and Luxembourg exceeds that with 1.61 computers per student. Notably, significant differences also exist outside Europe. For example, Australia reports a relatively high ratio of 1.18, whereas Chile (0.66) and Japan (0.57) fall below the one-to-one threshold. Interestingly, some countries geographically close to Spain, such as Portugal, report even lower ratios—for instance, only 0.39 computers per student—highlighting both regional and global disparities in digital infrastructure.

Figure 5.2

Number of computers per student in different countries (PISA data from 2018)



Note. Graph adapted from OECD (2020), retrieved from https://bit.ly/GEM2023_fig7_2.

Following this macro-system approach, studies like Chen et al. (2021) examined data from 20 OECD participating countries⁶. On the one hand, results indicated that digital reading habits had negative effects on enjoyment and digital literacy on most of the countries. On the other hand, digital reading habits had a null effect on reading self-concept in Asian territories, but small positive effects in most Western ones. Further research on different educational stages and cultures will contribute to form a more complete picture of the role of digital reading habits on reading comprehension in the modern world.

5.5. Final reflection

The present dissertation has explored new reading habits of our time, focusing on those that take place on-screen. We have seen how current digital reading habits tend to promote short and fast content. Some may even argue if there is any reading comprehension at all involved in processing such content. This concern is reflected in the findings of the present dissertation. By employing different statistical methodologies, we have observed weak to null relationships between digital reading habits and reading comprehension in the three studies of this dissertation. Following international trends, we have also shown how print reading habits present a declining tendency while digital ones keep rising in primary school students. Now that we know that digital reading habits are not related to reading comprehension, much more is needed to understand why. The present dissertation opens the floor and calls for future studies in this line. It also highlights that digital reading habits are in constant evolution, linked to technological and sociocultural changes. Right now, the emergence of artificial intelligence might introduce new changes in reading habits, just as once happened with the arrival of screens. AI appears to simplify and reduce even more the content we typically find on the internet. It is possible that in the future, deep reading

⁶ The Asian cities/countries/regions as representative of Confucian-influenced societies were Hong Kong, Japan, Macau, Singapore, South Korea, and Taipei. Western societies were Australia, Denmark, Finland, Germany, Ireland, New Zealand, Sweden, the United Kingdom, and the United States.

comprehension might not be even required to understand written long texts. While this could be perceived as a positive point in terms of efficiency in practical needs such as academic tasks, we call for caution. In this dissertation we have seen that digital reading habits, particularly those carried out for academic purposes, can influence negatively later intrinsic reading motivation. That is why we need to take action to avoid compromising the joy of reading in favour of speed and instant performance. From school-based interventions, we know that digital reading can be beneficial for both reading comprehension and reading motivation. Therefore, we emphasize the need to find ways in which the education community can foster the positive transference from school-based practices towards autonomous digital reading habits. Lastly, it is important to emphasize that digital reading habits frequency alone should not be considered the responsible for the worldwide reading comprehension and reading motivation detriments. We call for future research that can provide more information about the cognitive and behavioural processes that are being present in digital reading habits in relation to reading comprehension development.

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Appendix

Appendix A

Supplemental materials A1

Coding manual

The aim of this meta-analysis is to determine the relationship between digital reading habits and reading comprehension skills, examining studies that have analyzed this relationship from 2000 to 2022. In this document you will find the guide to code the information extracted from the selected studies; columns are referred to the Excel databases used to code the information.

General instructions

- If the needed information to complete any cell is not included in the document we would write: NR (not-reported).
- If the needed information to complete any cell is not applicable due to its characteristics we would write: NA (not applicable). In this case, we have to insert a comment in the cell, using the Excel tool “comments”. For example, in longitudinal studies, we cannot indicate the average age, just the ranges.
- If there are several sub-samples in the study, e.g: samples from different educational stages, we would add a new row below the principal one and we would code it with letters in alphabetical order (e.g: Pérez et al., 2000a; Pérez et al., 2000b).

Specific instructions by type of variables

1. Identification variables

They refer to general information about the studies and its publication characteristics:

A: The number of the study (to ease the recount of studies in each database)

B: Study name for coding

C: Title – Title of the study

D: Authors

E: DOI

F: Source (journal name)

G: Publicized: 0) No, 1) Yes

H: Publication year

I: Notes (things to take into account, commentaries)

2. Extrinsic variables

J: Publication type: 0) Dissertation, 1) Journal article, 2) Report, 3) Book, 4) Congress conference
label + if we obtained the data from other source

K: Country - Name of the country or countries from which data is obtained

L: Publication language: 0) Spanish, 1) English

(Coll_Data_Y) Year of data collection: when the study was conducted

3. Substantive variables

Variables referred to sociodemographic sample information and theoretical content useful for our study.

3.1. Sociodemographic data

Age (from column J to M)

(Edad_All) N: Age mean

If they belong to grades of different educational stages we will decide the level based on the age mean of the sample (see next section to select the most accurate option). Note: if they are undergraduate students we cannot know the age equivalence due to the large variability that can be found.

(Edad_All_SD) O: Standard deviation of the age mean

(Edad_Min) P: Minimum age of the sample

(Edad_Max) Q: Maximum age of the sample

Gender

We indicate the percentage of each gender.

(P_Fem) R: Feminine - Percentage of women/girls

(P_Masc) S: Masculine - Percentage of men/boys

Educational level of the sample (from column P to R)

This information is reported in varied ways, that is why we indicate first:

(Students) T: Students (yes: 1, no: 0)

(Student_level) U: The educational level to which they belong:

- 0: Not student sample
- 1: Pre-school (no hay ninguno)
- 2: Primary school
- 3: Middle school
- 4: High school
- 5: College (university and post-university studies)

(Secondary_level) V: Secondary: 0) middle school, 1) high school

W-X: If we have indicated 1, 2, 3 or 4 in the educational level, we detail the grade they are coursing. Usually, we will find more than one course so this information will be coded in minimum (Curso_Min) and maximum course (Curso_Max)

- If there is only one grade, we would write it down in the “maximum” option.
- As each country has its own educational system we need to homogenize this information, so we will use a table of equivalencies based on the sample age:

0. Pre-school (0): 3-6 years-old

Primary school

1. Grade 1: 6-7 years
2. Grade 2: 7-8
3. Grade 3: 8-9
4. Grade 4: 9-10
5. Grade 5: 10-11

Note: Secondary School involves Middle and High School.

Middle school

6. Grade 6: 11-12
7. Grade 7: 12-13
8. Grade 8: 13-14

High school

9. Grade 9: 14-15
10. Grade 10: 15-16
11. Grade 11: 16-17
12. Grade 12: 17-18

Higher studies

13. First grade (freshmen) undergraduates
14. Second grade undergraduates
15. Third grade undergraduates
16. Fourth grade undergraduates
17. Post-graduates (Master or PhD students)

Cross-countries differences

English and American education grades equivalence: check [here](#)

Finnish education grades equivalence according to age: check [here](#)

3.2. Digital reading habits (DRG) variables

(N_items_DRH) Y: N_items: Here we detail the number of items

Z: Item labels - Here we put the labels of the items (e.g: ebook reading, sending emails)

(Categories_DRH) Self-created categories grouping type of DRH: 1) social-communicative use, 2) Linear reading (digital equivalence of traditional print materials, informational pages, blogs), 3) Mix or unspecified

4. Methodological variables

4.1. Design and sampling

V: Collection data year - We indicate the year in which the study data was collected. E.g: some study can be published on 2019 but the data was collected in 2008.

AC: Total sample size

Y: Type of study - We identify if the authors have used: 0) No experimental methodology, 1) Quasi-experimental, 2) Experimental

- Z: If we have identified 0) No experimental methodology, we must indicate de type of non-experimental methodology: 0) Ex post facto, 1) Survey, 2) Descriptive, 3) Observational

AD: Temporal design - Methodological design based on temporal criteria: 0) cross sectional, 1) longitudinal

AE: Sampling procedure: 0) No probabilistic (convenient sampling), 1) Probabilistic (random sample selection, e.g.: stratified sampling, random sampling or by stages like PISA studies)

AF: Dependent variables: we identify the additional dependent variables studied besides the ones we are especially interested.

AG: Independent variables: we identify the additional independent variables studied besides the ones we are especially interested in.

AH: Control variables: we indicate whether they use control variables or not: 0) No control variables, 1) Control variables.

- AI: Specific CV - If we have coded control variables with “1” then we have to detail which variables are they by writing them down.

4.2. Questionnaire on reading habits

(Instrum_DRH) AJ: Instrument to collect data: 0) Survey (self-report), 1) Diary, 2) Parental-report, 3) Interview

(Tip_Cuest_DRH) AK: Type of questionnaire: 0) Ad-hoc/Non-standardized, 1) Standardized, 2)

Adapted from a standardized questionnaire

- AL: If we have coded “1” or “2” in Type of questionnaire, we then detail the name of the questionnaire.

AM: Answer format of the questionnaire - For example, when asked *How often do you read books?* The answer can be:

1. Open: 0 (the participant indicated the number of hours dedicated to book reading)
2. Closed: 1 (in which some alternatives are offered and the participant has to pick one, like Likert scales)

AN: Temporal range - Researchers can ask for habits based on: 0) Not specified, 1) Daily range, 2) Per week, 3) Mixed ranges (monthly, weekly, daily)

- AO: Label – We specify the labels of the answers alternatives.
- AP: Temporal classification – based on the scale alternatives, time can be measured in several ways:
 - 0) Hour ranges (e.g: from 0 to 1 h, 1-3h, 3-5h...)
 - 1) Frequency (never, sometimes, always)

- 2) Times per day, week or month (e.g: never, once/twice a week/month...almost every day/every day)
- 3) Mixed (hours, frequency, times)

AQ: Number of responses: Indicate the number of alternatives (e.g: in a 5 point Likert scale we would write “5”).

4.2.1. Reading habits questionnaire reliability

AR: Hab_q_rel Do they provide a value for the Reading habits questionnaire construct reliability? 0) No, 1) Yes

If 1) Yes, we will detail:

- AS: Type of reliability (0: Alpha de Cronbach, 1: Omega, 2: WLE, 3: ITR, 4: Unspecified)
- AT: Reliab_hab - Reliability value: the numerical value

4.2.2. Reading habits questionnaire validity

AR: Includes - Do they provide a value for the Reading habits questionnaire construct validity? 0) Yes, 1) No

If 0) Yes, we will detail:

- AS - Type of validity: predictive validity, relation with another instrument...
- AT - Validity value: the numerical value

4.3. Reading comprehension measures

(Media_RC) Media: How the RC test was presented (0) Print (1) Digital

(Tip_Test_RC) Type of test: 0) Ad-hoc, 1) Standardized, 2) Adapted from a standardized test

- AV: Test name - If we have coded “1” or “2” in Type of test, we then detail the name of it.

(Type/Genre_RC) AX: Type of assessment text: 0) narrative, 1) expository/informational, 2) descriptive, 3) mixed

(Numb_txt_RC) AY: Number of texts presented in the RC assessment

(Average_words_RC): Average words per text used as RC assessment

(Compr_Dime_RC) Type of compreh questions (RC Dimensions): 0: inferential, 1: literal, 2: both

AZ: Word count

BA: Theme of the text

Assessment method: 0: Multiple-Choice Question (MCQ), 1: Open-ended q, 2: Both (MCQ and Open), 3: CLOZE type,

BB: Mean of the reading comprehension test → Average of the different comprehension scores of all the texts, unless there's an independent design (they are separated)

BC: SD of the reading comprehension test

BD: Min of correct answers of RC test

BE: Max of correct answers of RC test

(Group_Ind) BF: How the test was taken ☐ Individual (1) or group assessment (0)

4.3.1. Reading comprehension test reliability

BG: Do they provide a value for the Reading comprehension test reliability? 0) No, 1) Yes

If 1) Yes, we will detail:

- BG: Type of reliability (0: Alpha de Cronbach, 1: Omega, 2: WLE, 3: ITR, 4: Unspecified)
- BH: Reliability value: the numerical value

4.3.2. Reading comprehension test validity

BH: Includes - Do they provide a value for the Reading comprehension test validity? 0) Yes, 1)

No

If 0) Yes, we will detail:

- BB - Type of validity: predictive validity, relation with another instrument...
- BC - Validity value: the numerical value

5. Output variables

The effect size is going to be studied, mainly, from correlational data between reading habits and reading comprehension scores. If we cannot get correlation values we would look for average scores, standard deviations and N of the variables. E.g: the score of reading comprehension according to each reading frequency option. If this information wasn't available, we opt to look for regression values. In this case, only standardized beta values will be useful.

BD: Relationship measure - To indicate the type of data used, in the next column we detail whether the data analysis are from: 0) correlational analysis (Pearson or Spearman), 1) regression analysis, 2) descriptive data.

BE: Own average – As some of the studies do not merge the information of the different items, we had to calculate the average of the items to refer to just one variable (“entertainment or academic digital reading habits”). In this column we identify whether:

- 0) Data was obtained directly from the study or because the author provided us with the data (and we did not make any transformations)
- 1) Average was performed from study data or data provided by authors
- 2) Average was performed from calculations with the database itself

BF: N – we detail the sample size again

BG: beta stand. – If the data comes from regression analysis, a conversion is needed, that is why we specify its value in a separated column. We detail the value of the standardized beta (without transformation).

BH: r - Finally, we detail the numerical value provided, in the case of Pearson or Spearman correlation coefficients this value is the equivalent of our effect size, thus, if it is one of this coefficients in the column “Effect size” we will write down this value. If we have data from regression analysis the next transformation is needed: $r = \beta \cdot \lambda$ (which is 0 if the beta value is negative, and 1 if the beta value is positive). Important: we can only make this transformation if the values are between -0,5 & +0,5.

Table A1

Summary of the comparisons made between studies that shared partially or completely the sample

Database	Study	Number of countries	Reasons of exclusion
PISA 2000	Bussière & Gluszynski (2004)	1	Not digital reading habits: Computer use
	Leino et al. (2004)	3	Descriptive report (not values)
	Woessmann & Fuchs (2004)	1	Not enough data to perform correlational analysis
PISA 2006	Gil-Flores (2013)	1	Only academic-related habits
	Gumus & Atalmis (2011)*	1	Elected
PISA 2009	Acar (2015)	1	
	Biagi & Loi (2013)	23	
	Chang et al. (2011)	4	
	Cheung et al. (2013)	2	
	Fariña et al. (2015)	4	
	Frønes et al. (2013)	1	
	Gil-Flores et al. (2012)	1	
	Lai (2016)	2	
	Lee & Wu (2013)	15	
	Lim & Jung (2019)	15	
	Ramberg (2014)	16	
	Sofianopoulou & Bountziouka (2011a)	1	
	Sofianopoulou & Bountziouka (2011b)	5	
	Wu & Peng (2017)*	19	Elected: Greatest number of countries and information available
	Yang (2012)	1	
PISA 2012	Agasisti et al. (2020)	12	
	Chiao & Chiu (2018)	1	

Table A1 (continued)

Database	Study	Number of countries	Reasons of exclusion
	Dinis da Costa & Araújo (2016)	8	
	Erdogdu & Erdogdu (2015)	1	
	Mediavilla & Escardibul (2015)	1	
	Naumann & Sälzer (2017)	1	
	Petko et al. (2017)*	39	Elected: Greatest number of countries and information available
PISA 2015	Gómez-Fernández & Mediavilla (2018)	1	
	Gubbels et al. (2020)	1	
	Hu et al. (2018)	44	Not enough data to perform correlational analysis
	Martínez-Abad et al. (2020)	1	
	Martínez-Garrido (2018)	1	
	Park & Weng (2020)*	39	Elected: Greatest number of countries and information available
	Rozgonjuk & Täht (2017)	1	
	Saarinen et al. (2021)	1	
	Srijamdee & Pholphirul (2020)	1	
	Vázquez-Cano et al. (2020)	1	
	Xiao & Hu (2019a)	1	
	Xiao & Hu (2019b)	1	
	Xiao et al. (2019)	5	
PISA 2018	Chen et al. (2021)	15	Comparison: greatest sample size but only 3 items for social media (chatting online (e.g., MSN), participating in social networks

Table A1 (continued)

Database	Study	Number of countries	Reasons of exclusion
			(e.g., Facebook, MySpace) and browsing for fun (e.g., watching videos on YouTube))
	Karakoyun & Başaran (2022)	1	Only ICT availability
	Kong et al. (2022)*	3	Elected: 6 items (reading emails, reading online news, chatting online, online information searches to learn about a particular topic, participating in online group discussions, and searching for practical information online).
Studies that gather PISA data from several years			
PISA 2009, 2012, 2015, 2018	Hu & Yu (2021)	57	No possibility to calculate the effect size
PISA 2009, 2018	Lee et al. (2021)	1	
PISA 2009, 2018	Luyten (2022)	63	Only information about 1 item (online chatting)
Studies that gather TIMSS and/or PIRLS data			
PIRLS 2011	Botello-Peñaloza & López-Alba (2014)	1	Not digital reading habits: Computer use
PIRLS 2001, 2006, 2011	Netten et al. (2014)	1	Not digital reading habits: Computer use
PIRLS 2001, 2006	Rosén & Gustafsson (2016)	9	Not digital reading habits: Computer use
TIMSS 2011, PIRLS 2011, and PISA 2012	Skryabin et al. (2015)	38	Not enough information about analysis and data employed

Table A1 (continued)

Database	Study	Number of countries	Reasons of exclusion
Studies that used data from a wider study			
Sample is part of the standardization of the York Assessment of Reading for Comprehension (YARC) Secondary test	McGeown et al. (2015) Duncan et al. (2016)*		We decided to select Duncan et al. (2016) study because they divided the sample according to the educational stage and provided more detailed item-reading skill correlations

References from the comparison table

References marked with an asterisk indicate studies finally included in the meta-analysis.

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Appendix B

Table B1
Summary of reading habits measures differentiating purpose and media in previous literature

Study	Participants' age	Reading media				Frequency		Psychometric properties	
		Reading purpose	Print	Digital	Measurement (indicated in the article)		Dimensionality	Internal consistency	
Duncan et al. (2016)	11 -15 (grade 7 to 9)	Leisure	Magazine Comic/graphic novel/manga Poetry Newspaper Song lyrics Set of instructions/manual Non-fiction book Fiction book	Text message/e-mails Networking website (e.g., Facebook) Computer/console game Online searching Factual website or blog (e.g., Wikipedia) Twitter	How much time they had spent reading the material the previous weekend Scale: a 5-point Likert scale (1: Didn't read this, 2: 30 min or less, 3: 1 hr, 4: 2 hr, 5: 3 hr or more).		Treated as independent items	-	
		Academic	School textbook/reference book	-				-	
Johnson (2013)	8-12 years (grade 3 to 6)	Leisure (two set of items: the first set ended with "at home" and the second with "at someone else's house", referred to as Community level)	-	I use the internet at... I use email at... I instant message at... I use the internet to play games at... I visit websites at...	No specific question or prompt detailed. Scale: Never or hardly ever, once or twice a month, once or twice a week, every day or almost every day		Treated as independent items	-	
		Academic (inside of school, items ended with "at school")	-					-	
Kannianinen et al. (2022)	12-13 (grade 6)	Leisure	Books (e.g., novels, nonfiction) Newspapers (an example of the Finnish newspaper) Magazines (examples of Finnish magazines targeted to adolescents) Comics	E-book Online newspapers (examples of Finnish online news-papers) Websites on various topics (e.g., interests, hobbies, sports) Blog posts Forums (e.g., discussions of games, artists, hobbies).	5-point Likert scale [1 = hardly ever; 2 = rarely (1–2 times per month); 3 = 1–2 times per week; 4 = almost every day; 5 = every day]			McDonald's omega = 0.62	

Table B1 (continued)

Reading media					Frequency		Psychometric properties	
Study	Participants' age	Reading purpose	Print		Digital	Measurement (indicated in the article)	Dimensionality	Internal consistency
McGeown et al. (2016)	8-11 (grade 3 to 5)	Leisure	Fiction/storybook Factual/information book Magazines Comics	On-line searching/web browsing Text messages Emails Social networking site (e.g., Facebook) Twitter		'How much time in an average week (including the weekend) do you usually spend reading each of these outside of school?' Scale: 5-point scale: 'Don't read this', 'Less than 1 hour', 'About 1-2 hours', 'About 3-4 hours' and '5 hours or more'.	Text messages, emails, social networking and twitter. items were summed to create a composite score measuring short digital texts used for communication	Only reported for the factor "short digital texts used for communication": Cronbach's alpha= .76
		Academic	School textbook					
Pfost et al. (2013)	12-13 years (grade 7)	Leisure	Magazines or newspapers Comics Novels Stories or tales Nonfiction books (e.g., technical or science)	E-mails Online encyclopedias (e.g., Wikipedia) Online forums or chats.		"Outside school, how often do you read...?": Scale: 4-point scale with the response options 1 (almost never or never), 2 (several times a month), 3 (several times a week), and 4 (several times a day).	Latent class analysis (LCA) model with binary latent class indicators and ordered categorical (ordinal) dependent variables. Obtained profiles: 1) Highly engaged readers: read all types of materials; 2) Online readers; 3) Traditional print readers; 4) Print avoidant readers	-
Torppa et al. (2020)	11-15 (grade 6 to 9)	Leisure	Reading frequency of books Newspapers Comic books Nonfiction books Interest-related books Tabloids Magazines Magazines for adolescents	E-mails Messages and Internet conversations Facebook Blogs		Leisure time reading activity Scale: 5-point Likert scale (1 = not at all or rarely to 5 = several times a day)	Factor analyses (using principal axis factoring, varimax rotation) 4 factors: 1. "Book reading": Number of books read in one's free time, Book reading frequency 2. "News and comics": Newspapers, Comic books, Nonfiction and interest-related books, and Tabloids. 3. "Magazines": Magazines, Magazines for adolescents. 4. "Digital texts": E-mails, Messages and Internet conversations, Facebook, Blogs.	Cronbach's alphas for Book reading: .73 in Grade 6, .80 in Grade 7, and .82 in Grade 9; for News and comics: .51 in Grade 6, .56 in Grade 7, and .55 in Grade 9; for Magazines: .53 in Grade 6, .61 in Grade 7, and .63 in Grade 9; and for Digital texts: .53 in Grade 6, .52 in Grade 7, and .46 in Grade 9.

Table B1 (continued)

Study	Participants' age	Reading media			Frequency Measurement (indicated in the article)	Psychometric properties	
		Reading purpose	Print	Digital		Dimensionality	Internal consistency
PIRLS 2016 Student questionnaire	(9-10 years) Grade 4	Not specified	-	Playing games Watching videos Chatting Surfing the internet	How much time do you spend each day using a computer or tablet for any of the following activities? Scale: No time, 30 min or less, 30 min up to 1 hour, from 1 h to 2 hours, 2h or more	-	-
		Academic (inside and outside school: At home, At school, Some other place)	-	Schoolwork	How often do you use a computer or tablet in each of these places for schoolwork (including classroom tasks, homework, or studying outside of class)? Scale: Never or almost never, Once or twice a month, once or twice a week, Every day or almost every day	-	-
ePIRLS 2016 Student questionnaire	(9-10 years) Grade 4	Not specified	-	Finding and reading information on the Internet	About how much time do you spend each day finding and reading information on the Internet? Scale: Less than 30 minutes, 30 minutes up to 1 hour, From 1 hour up to 2 hours, 2 hours or more	-	-
PIRLS 2021 Student questionnaire	(9-10 years) Grade 4	Not specified	No items - Low specific question		How often do you borrow books (including ebooks) from your school or local library? Scale: At least once a week -- A Once or twice a month -- A few times a year -- Never or almost never	-	-
		Not specified	No items - Low specific question		How much time do you spend reading outside of school on a normal school day? Scale: 30 min or less, 30 min up to 1 hour, from 1 h to 2 hours, 2h or more	-	-
		Leisure	I read for fun I read to find out about things I want to learn		How often do you do these things outside of school? Scale: Every day or almost every day, once or twice a week, once or twice a month, never or almost never	-	-

Table B2*Descriptive average for all items in fourth grade*

	N	Mean	SD	Skewness		Kurtosis	
Statistic				SE	Statistic	SE	
<i>Leisure scale</i>							
<i>Print format (average)</i>	696	1.14	0.55	0.34	0.09	0.01	0.19
Specific topics books	707	1.43	1.05	-0.01	0.09	-1.21	0.18
Fiction books paper	706	1.70	1.07	-0.22	0.09	-1.21	0.18
Comic books paper	704	1.04	1.14	0.61	0.09	-1.11	0.18
Magazines paper	709	0.39	0.74	1.97	0.09	3.23	0.18
<i>Digital format (average)</i>							
Books digital format	706	0.69	0.99	1.15	0.09	0.00	0.18
Internet for information	707	1.84	1.03	-0.43	0.09	-0.99	0.18
Internet to communicate	705	1.54	1.22	-0.12	0.09	-1.56	0.18
Leisure emails	705	1.20	1.17	0.37	0.09	-1.37	0.18
<i>Academic scale</i>							
<i>Print format (average)</i>	687	2.01	0.59	-0.58	0.09	-0.07	0.19
Fiction books paper	708	1.52	1.06	-0.11	0.09	-1.20	0.18
School books paper	705	2.03	1.03	-0.72	0.09	-0.67	0.18
Worksheets paper	704	2.12	0.92	-0.83	0.09	-0.18	0.18
Exercises notebook	695	2.38	0.84	-1.26	0.09	0.80	0.19
<i>Digital format (average)</i>							
School books digital	703	0.93	1.06	0.65	0.09	-0.99	0.18
Internet for homework	705	1.38	0.98	0.16	0.09	-0.97	0.18
Internet to understand	707	1.35	1.02	0.11	0.09	-1.13	0.18
Academic emails	707	0.94	1.05	0.73	0.09	-0.78	0.18

Table B3*Descriptive average for all items in fifth grade*

	N	Mean	SD	Skewness		Kurtosis	
				Statistic	SE	Statistic	SE
<i>Leisure scale</i>							
<i>Print format (average)</i>	646	1.07	0.57	0.43	0.10	-0.07	0.19
Specific topics books	656	1.36	1.05	0.12	0.10	-1.21	0.19
Fiction books paper	654	1.58	1.07	-0.12	0.10	-1.22	0.19
Comic books paper	654	0.97	1.13	0.73	0.10	-0.95	0.19
Magazines paper	658	0.38	0.70	1.87	0.10	2.85	0.19
<i>Digital format (average)</i>							
Books digital format	653	1.56	0.71	-0.18	0.10	-0.71	0.19
Internet for information	658	0.77	1.01	0.98	0.10	-0.39	0.19
Internet to communicate	659	2.09	0.93	-0.69	0.10	-0.53	0.19
Leisure emails	654	1.87	1.20	-0.54	0.10	-1.27	0.19
	657	1.53	1.15	-0.08	0.10	-1.42	0.19
<i>Academic scale</i>							
<i>Print format (average)</i>	640	2.07	0.55	-0.81	0.10	0.88	0.19
Fiction books paper	657	1.45	1.01	-0.05	0.10	-1.11	0.19
School books paper	652	2.15	0.94	-0.90	0.10	-0.18	0.19
Worksheets paper	652	2.16	0.84	-0.68	0.10	-0.30	0.19
Exercises notebook	650	2.51	0.75	-1.60	0.10	2.18	0.19
<i>Digital format (average)</i>							
School books digital	649	1.35	0.70	0.17	0.10	-0.75	0.19
Internet for homework	651	0.92	1.02	0.69	0.10	-0.83	0.19
Internet to understand	657	1.81	0.93	-0.39	0.10	-0.70	0.19
Academic emails	656	1.48	1.03	0.01	0.10	-1.15	0.19
	656	1.18	1.09	0.40	0.10	-1.16	0.19

Table B4*Descriptive average for all items in sixth grade*

	N	Mean	SD	Skewness		Kurtosis	
Statistic				SE	Statistic	SE	
<i>Leisure scale</i>							
<i>Print format (average)</i>	679	1.00	0.59	0.33	0.09	-0.43	0.19
Specific topics books	686	1.22	1.00	0.24	0.09	-1.08	0.19
Fiction books paper	688	1.45	1.09	0.06	0.09	-1.28	0.19
Comic books paper	684	0.89	1.11	0.86	0.09	-0.76	0.19
Magazines paper	685	0.45	0.74	1.66	0.09	2.30	0.19
<i>Digital format (average)</i>							
Books digital format	680	1.77	0.62	-0.43	0.09	-0.06	0.19
Internet for information	684	0.63	0.94	1.27	0.09	0.38	0.19
Internet to communicate	685	2.23	0.89	-0.92	0.09	-0.09	0.19
Leisure emails	684	2.46	0.90	-1.63	0.09	1.58	0.19
	685	1.76	1.11	-0.37	0.09	-1.22	0.19
<i>Academic scale</i>							
<i>Print format (average)</i>	674	2.03	0.58	-0.83	0.09	0.71	0.19
Fiction books paper	686	1.33	0.97	0.12	0.09	-0.99	0.19
School books paper	684	2.18	0.99	-0.97	0.09	-0.22	0.19
Worksheets paper	684	2.06	0.91	-0.70	0.09	-0.36	0.19
Exercises notebook	684	2.53	0.78	-1.71	0.09	2.27	0.19
<i>Digital format (average)</i>							
School books digital	678	1.55	0.71	-0.08	0.09	-0.75	0.19
Internet for homework	681	1.01	1.13	0.63	0.09	-1.10	0.19
Internet to understand	687	1.98	0.89	-0.52	0.09	-0.52	0.19
Academic emails	685	1.71	0.97	-0.29	0.09	-0.88	0.19
	686	1.49	1.12	0.00	0.09	-1.36	0.19

Table B5
Descriptive average for all items by gender

	Girls						Boys					
	Skewness			Kurtosis			Skewness			Kurtosis		
	N	Mean	SD	Statistic	SE	Statistic	N	Mean	SD	Statistic	SE	Statistic
Leisure scale												
<i>Print format (average)</i>	905	1.01	0.54	0.39	0.08	0.02	838	1.14	0.61	0.25	0.08	-0.35
Specific topics books	914	1.30	1.04	0.20	0.08	-1.17	853	1.42	1.03	0.00	0.08	-1.15
Fiction books paper	913	1.69	1.06	-0.21	0.08	-1.19	852	1.46	1.08	0.05	0.08	-1.26
Comic books paper	908	0.64	0.95	1.27	0.08	0.36	850	1.27	1.18	0.31	0.08	-1.42
Magazines paper	914	0.41	0.70	1.78	0.08	2.82	854	0.41	0.75	1.80	0.08	2.42
<i>Digital format (average)</i>												
Books digital format	904	1.61	0.73	-0.29	0.08	-0.75	846	1.51	0.70	-0.27	0.08	-0.59
Internet for information	911	0.77	1.00	0.98	0.08	-0.37	854	0.60	0.93	1.36	0.08	0.59
Internet to communicate	912	2.12	0.92	-0.73	0.08	-0.44	854	2.03	0.99	-0.65	0.08	-0.69
Leisure emails	911	1.95	1.18	-0.67	0.08	-1.11	848	1.93	1.18	-0.62	0.08	-1.16
	913	1.58	1.16	-0.14	0.08	-1.44	849	1.50	1.15	-0.03	0.08	-1.43
Academic scale												
<i>Print format (average)</i>	882	2.07	0.57	-0.80	0.08	0.61	841	2.00	0.59	-0.70	0.08	0.32
Fiction books paper	912	1.54	0.98	-0.10	0.08	-1.00	856	1.43	1.00	0.01	0.08	-1.08
School books paper	907	2.14	0.95	-0.89	0.08	-0.22	852	2.06	1.02	-0.76	0.08	-0.61
Worksheets paper	903	2.13	0.90	-0.78	0.08	-0.27	854	2.09	0.88	-0.69	0.08	-0.31
Exercises notebook	897	2.47	0.78	-1.49	0.08	1.61	848	2.43	0.82	-1.39	0.08	1.24
<i>Digital format (average)</i>												
School books digital	896	1.45	0.74	0.05	0.08	-0.80	845	1.31	0.72	0.16	0.08	-0.77
Internet for homework	904	1.09	1.10	0.44	0.08	-1.23	849	0.92	1.07	0.73	0.08	-0.86
Internet to understand	909	1.83	0.95	-0.36	0.08	-0.80	855	1.64	0.97	-0.17	0.08	-0.96
Academic emails	911	1.57	1.02	-0.14	0.08	-1.09	852	1.48	1.03	-0.01	0.08	-1.13
	910	1.31	1.11	0.23	0.08	-1.31	855	1.17	1.10	0.40	0.08	-1.20

Table B6

Sources of validity evidence categorization in previous studies and the present study

Source	Criterion	Previous studies	Analysis in this study	Results
Evidence based on internal structure	Dimensionality	Pfost et al. (2013): Latent class analysis to identify readers' profiles regarding reading media. Torppa et al. (2020): Exploratory Factor Analysis (4 factors)	CFA controlling for class cluster	Good model fit indexes: Leisure: RMSEA = .050, 90% CI [.041, .060]; CFI = .904; SRMR = .042 Academic: RMSEA = .024, 90% CI [.014, .034]; CFI = .985; SRMR = .026
	Internal consistency	Kannianen et al. (2022): McDonalds' Omega = .62 (unidimensional) McGeown et al. (2016): Cronbach Alpha for digital texts = .76 Torppa et al. (2020): Cronbach Alpha values for ranging from .46 to .82 (for 4 factors)	Composite reliability based on CFA controlling for class cluster	Leisure print: .367 Leisure digital: .633 Academic print: .581 Academic digital: .722
	Relationship with reading comprehension	Leisure print: positive associations (Schiefele et al., 2012; Soemer & Schiefele, 2018; Troyer et al., 2019) Leisure digital: null to negative associations (Altamura et al., 2025; McGeown et al., 2016; Pfost et al., 2013; Torppa et al., 2020) Academic print: null associations (McGeown et al., 2016) Academic digital: from adolescents' studies- null (Park et al., 2020) to negative associations (Petko et al., 2017)	Pearson correlation	Leisure print: positive associations Leisure digital: negative associations Academic print: null associations Academic digital: negative associations

Source	Criterion	Previous studies	Analysis in this study	Results
Evidence based on relations to other variables	Relationship with intrinsic reading motivation	Leisure print: positive associations (Schiefele et al., 2012; Soemer & Schiefele, 2018; Troyer et al., 2019) Leisure digital: null to negative associations (McGeown et al., 2016) Academic print: null to positive associations (McGeown et al., 2016) Academic digital: -	Pearson correlation	Leisure print: positive associations Leisure digital: negative associations Academic print: positive associations Academic digital: negative associations
	Relationship with extrinsic reading motivation	Leisure print: negative (Becker et al., 2010; Wang & Guthrie, 2004; Troyer et al., 2019) Leisure digital: positive associations (McGeown et al., 2016) Academic print: null to positive associations (McGeown et al., 2016) Academic digital: -	Pearson correlation	Leisure print: negative associations Leisure digital: positive associations Academic print: positive associations Academic digital: positive associations

Supplemental materials B1

Multidimensional Reading Habits Instrument for primary school students (translated into English)

Leisure reading frequency questionnaire

How many times do you do the following reading activities outside of school (at home, in the library, at a relative's house)? We ask about what you read on paper or on the computer (or tablet) because you like it and you feel like doing it, as long as it is not in the school. (Select your answer with an X).

<i>I read because I choose to (for fun)...</i>	Never or almost never	Once or twice a month	Once or twice a week	Every or almost every day
Paper books on topics that interest me (i.e. about the Universe, prehistory, sports...)				
Fiction books on paper (tales or novels that tell a story about some characters)				
Comic books on paper (also mangas or graphic novels)				
Magazines on paper				
Books on tablet or e-book				
On the Internet, to look for things that interest me (i.e. a song's lyrics, a cooking recipe, e-news, timetables...)				
On the Internet, to communicate with other people (i.e. WhatsApp, Instagram, Discord, Skype)				
On the Internet, to receive and send emails (e-mails) to relatives or friends				

Academic reading frequency questionnaire

How many times do you do the following activities outside of school? This time, we ask about what you read on paper or on the computer (or tablet) because it has been sent at school as homework or as a task to do at home. (Select your answer with an X).

<i>I read because my teacher asks me to...</i>	Never or almost never	Once or twice a month	Once or twice a week	Every or almost every day
Fiction books on paper (tales, comics, novels that tell a story about some characters)				
Text books (the ones from the subjects)				
Worksheets from class				
Activities from my notebook				
Text books (the ones from the subjects) in tablet or e-book				
On the Internet, to look for information to do my homework (i.e. use an online dictionary, check webpages like Wikipedia...)				
On the Internet, to look for information that helps to understand better a topic (i.e. explanations in educational webpages or YouTube)				
On the Internet, to receive and send emails (e-mails) to teachers or classmates				

Appendix C

Supplemental materials C1

Detailed information about the ACL reading comprehension texts and items per grade: fourth

Text	Type of text	Number of words	Items and type of reading comprehension dimension
1	Narrative	80	Item 1: Evaluation, Item 2: Evaluation, Item 3: Inferential, Item 4: Inferential
2	Expository	52	Item 5: Literal, Item 6: Literal, Item 7: Literal, Item 8: Synthesis
3	Narrative	110	Item 9: Inferential, Item 10: Evaluation, Item 11: Inferential
4*	Expository	54	Item 12: Inferential, Item 13: Inferential, Item 14: Inferential
5	Expository	86	Item 15: Literal, Item 16: Literal, Item 17: Inferential, Item 18: Synthesis
6	Narrative	70	Item 19: Literal, Item 20: Inferential, Item 21: Inferential
7	Expository	79	Item 22: Literal, Item 23: Literal, Item 24: Literal, Item 25: Synthesis
8*	Narrative	66	Item 26: Inferential, Item 27: Inferential, Item 28: Synthesis

Note. Asterisk indicates which texts and corresponding items were employed as anchoring items in fifth grade.

Supplemental materials C2

Detailed information about the ACL reading comprehension texts and items per grade: fifth

Text	Type of text	Number of words	Items and type of reading comprehension dimension
1	Narrative	106	Item 1: Synthesis, Item 2: Inferential, Item 3: Evaluation
2	Expository	107	Item 4: Inferential, Item 5: Inferential, Item 6: Synthesis
3	Graphical information	193 (cinema timetables)	Item 7: Inferential, Item 8: Literal, Item 9: Literal, Item 10: Inferential
4	Narrative	163	Item 11: Inferential, Item 12: Inferential, Item 13: Inferential, Item 14: Inferential
5	Graphical information	27 + figure with people with different characteristics	Item 15: Synthesis, Item 16: Synthesis, Item 17: Synthesis, Item 18: Synthesis
6	Narrative	155	Item 19: Evaluation, Item 20: Inferential, Item 21: Evaluation, Item 22: Inferential
7	Expository	121	Item 23: Literal, Item 24: Literal, Item 25: Evaluation
8*	Graphical information	79 + map	Item 26: Literal, Item 27: Inferential, Item 28: Literal, Item 29: Inferential
9*	Expository	96	Item 30: Synthesis, Item 31: Evaluation, Item 32: Inferential
10	Narrative	59	Item 33: Synthesis, Item 34: Inferential, Item 35: Inferential

Note. Asterisk indicates which texts and corresponding items were employed as anchoring items in sixth grade.

Supplemental materials C3

Detailed information about the ACL reading comprehension texts and items per grade: sixth

Text	Type of text	Number of words	Items and type of reading comprehension dimension
1	Narrative	110	Item 1: Inferential, Item 2: Evaluation, Item 3: Inferential, Item 4: Literal
2	Expository	98	Item 5: Synthesis, Item 6: Literal, Item 7: Synthesis
3	Narrative	42	Item 8: Inferential, Item 9: Inferential, Item 10: Synthesis
4	Graphical information	104 (discontinuous format)	Item 11: Literal, Item 12: Literal, Item 13: Literal, Item 14: Literal
5	Narrative	166	Item 15: Inferential, Item 16: Inferential, Item 17: Evaluation, Item 18: Inferential
6	Narrative	172	Item 19: Inferential, Item 20: Inferential, Item 21: Evaluation, Item 22: Evaluation
7	Graphical information	142 (bus time-tables and ticket prices)	Item 23: Literal, Item 24: Synthesis, Item 25: Literal, Item 26: Literal, Item 27: Synthesis
8	Expository	131	Item 28: Synthesis, Item 29: Synthesis, Item 30: Inferential
9	Graphical information	281 (time-tables, menus and prices of 5 restaurants)	Item 31: Literal, Item 32: Literal, Item 33: Inferential
10	Expository	101	Item 34: Inferential, Item 35: Synthesis, Item 36: Inferential

Supplemental materials C4

Narrative description of the type of questions included in the reading comprehension test (ACL), translated into English

An example of multiple-choice literal question from an expository text (grade 6 version) is: “What stimulates life in dry areas? A) Water; B) Plants; C) Flowers; D) Insects; E) Larvae.” A correct response for this question indicates that the reader has understood the explicit information from the text (In drier areas, where water is very scarce, when rain arrives, there is a veritable explosion of life, both plant and animal), and that he/she has been able to develop a coherent text-based representation. An example of multiple-choice synthesis question from the same text is: “What is the main idea that encompasses both paragraphs? A) Winter is a difficult time for nature; B) Natural conditions make life difficult or easier for living beings; C) Dry areas can sometimes be extremely vital; D) Many animals migrate due to climatic difficulties; E) Animals and plants need water to reproduce.” A correct response for this question indicates that the reader has understood the information from the two paragraphs conforming the text and that he/she is able to draw intratextual connections.

One example of multiple-choice inferential question from a narrative text (grade 4 version) is: “Why do you think his mother gets up and leaves? A) Because she wants to go to another shoe store; B) Because she is in a hurry; C) Because she is angry with Juan; D) Because she doesn't like sneakers; E) Because she doesn't need sneakers.” To correctly answer this question the reader needs to go beyond the explicit information in the text. A correct response for this question indicates that the reader has elaborated inferences between the information in the text (He tries on some that fit him very well, but when he sees the brand, he tells his mother he doesn't want them. "I want some Weber sneakers; they are much better because they are advertised on TV."), and their own previous knowledge. In this text, a mother is trying to buy new sneakers for her son, but he is reluctant since they are not from a specific trendy brand. The reader needs to understand that the mother is upset due to her son attitude, which is not explicitly stated in the text. Lastly, an example of multiple-choice evaluation question from the same text is: “Do you think the reason Juan gives for choosing sneakers is good enough? A) Yes, because he wants some Weber sneakers; B) Yes, because they are advertised on TV; C) No, because they are not as pretty; D) No, because that doesn't mean they are better; E) No, because she already has other ones at home”. In this type of question, the reader needs to elaborate on judgements about the main character of the story, considering that his preference is only based on that those sneakers are advertised on TV.

Table C1
Independent Samples T-Test for gender

	Statistic	df	<i>p</i>	Mean difference	SE difference	Mean		SD	
						Girls	Boys	Girls	Boys
Leisure digital reading habits 4	1.85	737	.065	0.10	0.06	1.39	1.29	0.77	0.73
Leisure digital reading habits 5	2.01	693	.045	0.11	0.05	1.56	1.45	0.70	0.72
Leisure digital reading habits 6	3.88	711	<.001	0.19	0.05	1.70	1.51	0.64	0.66
Academic digital reading habits 4	1.90	735	.058	0.10	0.05	1.21	1.11	0.71	0.74
Academic digital reading habits 5	0.63	675	.532	0.03	0.05	1.38	1.35	0.71	0.71
Academic digital reading habits 6	1.21	700	.226	0.06	0.05	1.42	1.35	0.70	0.70
Intrinsic reading motivation 4	4.83	706	<.001	0.36	0.08	2.86	2.50	0.99	1.02
Intrinsic reading motivation 5	5.12	670	<.001	0.43	0.08	2.67	2.25	1.08	1.08
Intrinsic reading motivation 6	5.06	692	<.001	0.45	0.09	2.53	2.09	1.18	1.15
Reading comprehension 4	1.99	755	.047	0.16	0.08	0.09	-0.07	1.03	1.16
Reading comprehension 5	1.13	714	.259	0.07	0.06	0.65	0.58	0.85	0.88
Reading comprehension 6	1.40	724	.162	0.09	0.07	1.34	1.25	0.83	0.95

Table C2
Independent Samples T-Test for type of school

	Statistic	df	<i>p</i>	Mean difference	SE difference	Mean		SD	
						Public	No-public	Public	No-public
Leisure digital reading habits 4	-2.46	749	.014	-0.22	0.09	1.54	1.32	0.84	0.74
Leisure digital reading habits 5	-1.38	703	.169	-0.12	0.09	1.62	1.50	0.75	0.71
Leisure digital reading habits 6	0.82	717	.412	0.06	0.08	1.54	1.61	0.80	0.64
Academic digital reading habits 4	-1.00	749	.316	-0.08	0.08	1.23	1.15	0.84	0.71
Academic digital reading habits 5	-0.98	684	.329	-0.09	0.09	1.44	1.36	0.70	0.71
Academic digital reading habits 6	-0.54	706	.593	-0.04	0.08	1.43	1.38	0.72	0.70
Intrinsic reading motivation 4	3.61	719	<.001	0.43	0.12	2.30	2.73	1.03	1.01
Intrinsic reading motivation 5	2.59	679	.010	0.36	0.14	2.15	2.51	0.98	1.10
Intrinsic reading motivation 6	4.85	698	<.001	0.70	0.14	1.69	2.39	1.12	1.17
Reading comprehension 4	12.12	770	<.001	1.42	0.12	-1.27	0.14	1.16	1.01
Reading comprehension 5	7.85	724	<.001	0.78	0.10	-0.08	0.69	0.81	0.84
Reading comprehension 6	8.17	730	<.001	0.83	0.10	0.55	1.38	0.73	0.87

Table C4*Independent Samples T-Test for SEN status*

	Statistic	df	P	Mean difference	SE difference	Mean		SD	
						No SEN	SEN	No SEN	SEN
Leisure digital reading habits 4	1.21	749	.227	0.08	0.06	1.29	1.37	0.76	0.75
Leisure digital reading habits 5	0.93	703	.351	0.06	0.06	1.47	1.53	0.73	0.70
Leisure digital reading habits 6	0.41	717	.682	0.02	0.06	1.59	1.61	0.66	0.66
Academic digital reading habits 4	2.51	749	.012	0.15	0.06	1.05	1.20	0.74	0.72
Academic digital reading habits 5	4.22	684	<.001	0.26	0.06	1.17	1.43	0.68	0.71
Academic digital reading habits 6	7.13	706	<.001	0.41	0.06	1.09	1.50	0.62	0.69
Intrinsic reading motivation 4	2.15	719	.032	0.18	0.09	2.55	2.73	1.12	0.98
Intrinsic reading motivation 5	2.49	679	.013	0.24	0.10	2.30	2.53	1.10	1.09
Intrinsic reading motivation 6	-0.55	698	.586	-0.05	0.10	2.36	2.30	1.08	1.22
Reading comprehension 4	5.14	770	<.001	0.47	0.09	-0.36	0.10	1.20	1.07
Reading comprehension 5	3.22	724	.001	0.24	0.07	0.43	0.67	0.78	0.89
Reading comprehension 6	3.66	730	<.001	0.27	0.07	1.10	1.37	0.95	0.86

Table C5
Pearson correlation matrix for all study variables

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
<i>Leisure digital reading habits</i>																								
1. Grade 4	—																							
2. Grade 5	.47***	—																						
3. Grade 6	.37***	.49***	—																					
<i>Academic digital reading habits</i>																								
4. Grade 4	.49***	.34***	.28***	—																				
5. Grade 5	.23***	.50***	.35***	.36***	—																			
6. Grade 6	.26***	.38***	.50***	.27***	.45***	—																		
<i>Reading comprehension</i>																								
7. Grade 4	-.07	-.06	-.05	-.07	-.07	-.05	—																	
8. Grade 5	-.13***	-.12**	-.12**	-.12**	-.12**	-.12**	.64***	—																
9. Grade 6	-.15***	-.15***	-.15***	-.14***	-.15***	-.14**	.64***	.68***	—															
<i>Intrinsic reading motivation</i>																								
10. Grade 4	-.06	-.05	-.09*	.01	-.12**	-.10*	.20***	.20***	.23***	—														
11. Grade 5	-.07	-.05	-.08*	-.07	-.06	-.10*	.25***	.23***	.24***	.59***	—													
12. Grade 6	-.18***	-.17***	-.08*	-.14***	-.19***	-.08*	.25***	.23***	.29***	.51***	.65***	—												
<i>Leisure print reading habits</i>																								
13. Grade 4	.06	-.01	-.04	.15***	-.01	-.03	.13***	.11**	.11**	.41***	.35***	.31***	—											
14. Grade 5	.03	-.03	-.08*	.00	-.03	-.06	.10*	.07	.12**	.33***	.49***	.34***	.49***	—										
15. Grade 6	-.02	-.11**	-.07	-.06	-.11**	-.03	.06	.05	.04	.21***	.28***	.38***	.37***	.49***	—									
<i>Academic print reading habits</i>																								
16. Grade 4	.11**	.01	.04	.25***	.04	-.01	.09*	.07	.03	.25***	.15***	.10*	.26***	.15***	.08*	—								
17. Grade 5	.09*	.12**	.12**	.08*	.15***	.06	.09*	.09*	.04	.10*	.21***	.13**	.08*	.21***	.06	.15***	—							
18. Grade 6	.031	.01	.17***	.03	.07	.21***	.06	.03	.01	.15***	.19***	.19***	.12**	.13**	.10**	.11**	.24***	—						
<i>Extrinsic reading motivation</i>																								
19. Grade 4	.18***	.15***	.09*	.20***	.14***	.16***	-.30***	-.28***	-.28***	-.19***	-.12**	-.18***	-.05	.01	-.04	-.01	.00	-.03	—					
20. Grade 5	.20***	.23***	.16***	.21***	.19***	.18***	-.24***	-.29***	-.26***	-.20***	-.22***	-.23***	-.09*	-.02	.00	-.03	-.00	-.02	.45***	—				
21. Grade 6	.16***	.14***	.19***	.17***	.16***	.23***	-.23***	-.23***	-.23***	-.23***	-.19***	-.23***	-.10*	-.03	.05	-.10*	-.03	-.02	.33***	.47***	—			
<i>School digital access level^a</i>																								
22. Grade 4	.17***	.21***	.20***	.24***	.25***	.25***	.00	.00	.03	-.06	.04	-.10**	-.02	-.03	-.13**	-.02	-.06	-.08*	.04	.07	.00	—		
23. Grade 5	.10**	.14***	.15***	.15***	.27***	.26***	.00	.00	.01	-.03	.03	-.05	.01	.00	-.14**	.04	-.14***	-.04	.00	.05	-.05	.72***	—	
24. Grade 6	.04	.13***	.24**	.10*	.24***	.35***	.04	.03	.02	.00	.04	-.04	.04	.01	-.09*	.03	-.13***	-.05	-.05	.00	-.11**	.61***	.85***	—
25. Books at home ^a	-.07	-.07	-.04	-.03	-.04	.02	.28***	.21***	.23***	.19***	.16*	.16***	.23***	.16***	.13***	.07	-.02	.05	-.15***	-.12***	-.09*	.03	.07*	.14***

Note. ^a Spearman correlation * $p < .05$, ** $p < .01$, *** $p < .001$.

Table C6

Intra-class Correlation Coefficient (ICC) for school clustering: changes with included control variables

Variables	ICC without control variables	ICC after controlling for school type and school digital level access	ICC after controlling for school type and school digital level access, gender, SEN status, and number of books at home SES
<i>Leisure digital reading habits</i>			
Grade 4	0.12	0	0
Grade 5	0.17	0	0
Grade 6	0.18	0	0
<i>Academic digital reading habits</i>			
Grade 4	0.19	0	0
Grade 5	0.28	0	0
Grade 6	0.38	0	0
<i>Reading comprehension</i>			
Grade 4	0.11	0.07	0.07
Grade 5	0.14	0.13	0.13
Grade 6	0.14	0.13	0.12
<i>Intrinsic reading motivation</i>			
Grade 4	0.04	0	0
Grade 5	0.05	0	0
Grade 6	0.06	0	0
<i>Leisure print reading habits</i>			
Grade 4	0.03	0	0
Grade 5	0.02	0	0
Grade 6	0.03	0	0
<i>Academic print reading habits</i>			
Grade 4	0.11	0	0
Grade 5	0.06	0	0
Grade 6	0.02	0	0
<i>Extrinsic reading motivation</i>			
Grade 4	0.03	0	0
Grade 5	0.05	0	0
Grade 6	0.10	0	0

Resumen extenso

La presente tesis ha explorado los nuevos hábitos de lectura y su relación con la comprensión lectora, con un interés particular en los hábitos de lectura en formato digital. Consta de cinco capítulos en los que, en primer lugar, contextualizamos el tema a través de una introducción teórica; a continuación, presentamos tres estudios empíricos; y, por último, ofrecemos una discusión general. En el Capítulo 1 (Introducción Teórica) se revisa cómo ha evolucionado la definición de comprensión lectora, incorporando y conectando factores como el texto, el lector y el contexto. En concreto, se describen tres tendencias teóricas que se centran en cada uno de estos elementos. Al inicio, las primeras teorías sobre la comprensión lectora se centraban principalmente en el texto, siguiendo modelos ascendentes que concebían la lectura como un proceso lineal de decodificación, donde el significado residía en las características del propio texto. Con el avance de la psicología cognitiva, en las décadas de 1960 y 1970 se produjo un cambio hacia un enfoque centrado en el lector, que destacó la importancia de los procesos cognitivos internos. Este enfoque subrayó el papel del conocimiento previo, la memoria y los esquemas mentales en la comprensión. Paralelamente, se reconoció el peso del contexto en la lectura, señalando que la comprensión lectora no puede entenderse completamente sin considerar factores sociales, culturales y ambientales. A comienzos del siglo XXI surgió un enfoque holístico en el que la comprensión lectora se entiende como el resultado de la interacción entre cuatro elementos clave: el lector, el texto, el contexto y la propia actividad de lectura. Este marco reconoce que la comprensión depende de la combinación de habilidades cognitivas, conocimientos previos, motivación, características del texto y factores sociales y ambientales. Relacionado con dichos factores sociales y ambientales, en esta tesis se señala el avance tecnológico como promotor de cambios en los contenidos y medios de lectura disponibles, configurando así los hábitos de los lectores e introduciendo

nuevas concepciones de comprensión lectora. Estos cambios son tangibles cuando analizamos los ítems utilizados para medir los hábitos lectores en papel y en digital de evaluaciones internacionales, evidenciando un incremento de la cantidad y variedad de ítems referentes a la lectura digital con el paso de los años. Las concepciones teóricas de la comprensión lectora también experimentan una evolución, emergiendo modelos sobre comprensión lectora digital (ya sea en línea o estática), comprensión de textos múltiples (incluyendo la evaluación de fuentes, habilidades de navegación, integración y contrastación de la información), evaluaciones dinámicas en entornos realistas... A partir de datos de evaluaciones internacionales a gran escala, se destacan las tendencias actuales de disminución en los hábitos de lectura en papel y el aumento de aquellos realizados en dispositivos digitales. Estas tendencias resultan preocupantes ya que la literatura previa ha señalado, por un lado, que la lectura en papel se relaciona positivamente con la comprensión y motivación lectora. Y, por otro, literatura emergente ha señalado que leer en papel conlleva una ventaja frente a la lectura en digital en la comprensión lectora. Sin embargo, los estudios disponibles hasta la fecha no han examinado en profundidad cómo los hábitos de lectura en formato digital (i.e., la frecuencia lectora) se relaciona con la comprensión lectora, evidenciando una incógnita todavía por esclarecer. Además, los niveles decrecientes de comprensión lectora y motivación lectora a nivel mundial, junto con el incremento de frecuencia lectora digital señalan la necesidad de explorar la dinámica entre estas variables con el fin de determinar el rol de los hábitos lectores digitales en los estudiantes hoy en día. En relación con estas necesidades, la presente tesis persiguió dos objetivos principales. En primer lugar, se propuso investigar la relación entre los hábitos de lectura digital y la comprensión lectora a partir de la literatura existente (Estudio 1). En segundo lugar, se buscó explorar las asociaciones longitudinales entre los hábitos de lectura digital, la comprensión lectora y la motivación lectora en

estudiantes de Educación Primaria en España (Estudios 2 y 3). Estos dos objetivos fueron planteados de forma complementaria, con el fin de ofrecer una comprensión más completa de las interrelaciones entre los hábitos de lectura digital y la comprensión lectora.

En el Capítulo 2 se presenta el Estudio 1, un metaanálisis que examinó la relación entre los hábitos de lectura digital y la comprensión lectora a partir de un conjunto de 26 estudios (40 tamaños del efecto) publicados entre los años 2000 y 2022. El proceso de búsqueda arrojó 1866 registros inicialmente. Siguiendo los criterios de inclusión y exclusión, se consideraron 26 estudios para realizar el cálculo del tamaño del efecto, incluyendo datos de 469.564 individuos. El tamaño del efecto utilizado para medir la relación entre los hábitos de lectura digital y las puntuaciones de comprensión lectora fue el coeficiente de correlación de Pearson (r). Los coeficientes de correlación de Pearson se transformaron en la métrica Z de Fisher para normalizar las distribuciones y estabilizar las varianzas. Para facilitar la interpretación de los resultados, se transformaron nuevamente en coeficientes de correlación. Se aplicó un metanálisis de efectos aleatorios de tres niveles para abordar el hecho de que algunos tamaños del efecto estaban anidados dentro de los estudios. Este modelo se adaptaba mejor a nuestros datos porque varios de los estudios primarios analizados contenían información de submuestras independientes. En lugar de agregar la información de cada submuestra, con este análisis multinivel pudimos trabajar con tamaños del efecto individuales, controlando al mismo tiempo la dependencia a nivel de estudio, lo que también aumentó la potencia estadística. En este modelo, el primer nivel representa un modelo de tamaño del efecto intra-efecto, el segundo nivel muestra la variación entre los tamaños del efecto dentro del mismo estudio y el tercero representa la variación entre estudios. A pesar de que el nivel de participación solo contribuyó a un tamaño del efecto (los errores de muestreo son condicionalmente

independientes), la no independencia podría introducirse en la estructura anidada del tamaño del efecto. Con el análisis de efectos aleatorios de tres niveles, pudimos analizar la heterogeneidad entre estudios que no se detectaría en los datos agregados. El tamaño del efecto promedio reflejó un efecto pequeño pero significativo sobre la comprensión lectora, en contraste con los efectos de tamaño medio encontrados en la literatura sobre hábitos de lectura en papel y comprensión. Esta relación estuvo moderada significativamente por la etapa educativa del lector. En las etapas iniciales (educación Primaria y Secundaria) se observaron relaciones negativas entre la lectura digital por ocio y la comprensión de textos, mientras que en etapas más avanzadas (Bachillerato y Universidad) la relación pasó a ser positiva. La pequeña asociación negativa encontrada en estudiantes más jóvenes puso de manifiesto la necesidad de seguir explorando en profundidad los hábitos de lectura digital y su relación con la comprensión lectora. Con este fin, se llevaron a cabo dos estudios centrados en alumnado de cuarto a sexto de Educación Primaria en Valencia, España.

En el Capítulo 3 se describe el Estudio 2, motivado por la considerable heterogeneidad observada en la medición de los hábitos de lectura digital en el Estudio 1. En este estudio se desarrolló un instrumento capaz de medir los hábitos de lectura del alumnado diferenciando entre el soporte de lectura (papel o digital) y la finalidad de la lectura (ocio o académica). En total, participaron en este estudio 2.077 estudiantes. Los alumnos cursaban tres cursos escolares correspondientes a los últimos años de educación primaria en España: cuarto, quinto y sexto de primaria de centros escolares de la Comunidad Valenciana. Este instrumento recibió el nombre de Multidimensional Reading Habits Instrument (MRHI) [Instrumento Multidimensional de Hábitos de Lectura] y consta de dos cuestionarios, categorizados según la finalidad de la lectura, en los que el alumnado indica su frecuencia de lectura en diferentes actividades lectoras. Cada

cuestionario contiene ocho ítems, divididos equitativamente entre actividades en papel y en formato digital. Los resultados descriptivos proporcionaron información sobre las tendencias lectoras actuales de los estudiantes de primaria. Fuera del horario escolar, nuestros datos mostraron que los estudiantes de cuarto a sexto grado tienden a leer con mayor frecuencia con fines académicos, especialmente en formato impreso. La segunda actividad más frecuente observada fue la lectura digital por ocio, seguida de la lectura digital académica, siendo la lectura impresa por ocio la actividad menos frecuente. Nuestros hallazgos presentaron algunas discrepancias en comparación con los resultados de estudios previos que han indicado frecuencias más altas en hábitos de lectura impresa por ocio. En nuestro estudio, la mayor frecuencia de lectura de materiales impresos académicos, en comparación con estudios previos, podría deberse a la escasa o nula representatividad de los hábitos de lectura académica en estudios anteriores. Dado que el MRHI aborda explícitamente los diferentes propósitos de lectura, las respuestas de los estudiantes podrían ser algo diferentes a las de los estudios que no presentaron ítems tan diferenciados. En cuanto a las evidencias de validez, el MRHI presentó buenos resultados tanto en la estructura interna como en las relaciones test-criterio con la comprensión lectora y la motivación lectora. Estas relaciones test-criterio fueron coherentes con la literatura previa y se alinearon con los hallazgos del Estudio 1. Concretamente, los hábitos de lectura digital mostraron correlaciones negativas tanto con la comprensión lectora como con la motivación intrínseca, mientras que los hábitos de lectura en papel se asociaron positivamente con ambas. Una vez validado este instrumento, lo empleamos en un estudio longitudinal (Estudio 3).

En el Estudio 3, presentado en el Capítulo 4, abordamos directamente el segundo objetivo de investigación de esta tesis: examinamos las relaciones dinámicas entre los hábitos de lectura digital (por ocio y académica), la comprensión lectora y la motivación

intrínseca por la lectura a lo largo del tiempo. Con este fin, se hizo seguimiento de 908 alumnos y alumnas de cuarto a sexto de Primaria en la provincia de Valencia, evaluándoles anualmente en cuanto a su frecuencia de hábitos lectores, comprensión lectora y niveles de motivación lectora. En este estudio el enfoque estuvo en los hábitos lectores digitales según el propósito lector: por ocio o con fines académicos. Este estudio analizó las relaciones causales entre los hábitos de lectura digital, la motivación intrínseca por la lectura y la comprensión lectora durante los últimos cursos de educación primaria, ofreciendo aportaciones novedosas a la literatura: por primera vez se modelaron simultáneamente estas tres variables a largo plazo, diferenciando entre lectura digital por ocio y lectura digital académica, utilizando dos análisis de datos complementarios. Por un lado, empleamos modelos de panel con efectos cruzados (CLPM), pudiendo estimar relaciones direccionales a largo plazo entre los hábitos de lectura digital, la motivación intrínseca y la comprensión lectora. Estos análisis permitieron realizar comparaciones con estudios previos que se basaron en diseños transversales o en modelos de ecuaciones estructurales longitudinales estándar. Nuestros resultados a partir del CLPM indicaron la existencia inicial de caminos causales recíprocos entre la comprensión lectora y la motivación intrínseca por la lectura tanto en los modelos de lectura por ocio como académica. Específicamente, la comprensión lectora en cuarto curso predijo positivamente la motivación intrínseca en quinto curso, y viceversa. No obstante, este patrón bidireccional se debilitó con el tiempo, de manera que solo la motivación intrínseca en quinto curso predijo la comprensión en sexto curso. En general, estos hallazgos coinciden con investigaciones previas que utilizaron diseños transversales unidireccionales o estudios longitudinales con puntos de medición limitados, que apoyan el papel predictivo de la motivación sobre la comprensión lectora. Por otro lado, aplicamos el modelo de panel con interceptos aleatorios y efectos cruzados (RI-CLPM),

que proporciona aproximaciones causales más sólidas al aislar los cambios dentro de cada individuo a lo largo del tiempo, teniendo en cuenta las diferencias estables entre personas. Este enfoque nos permitió explorar cómo las fluctuaciones individuales en los hábitos de lectura digital pueden preceder cambios en la motivación y la comprensión, de manera independiente a la estabilidad de rasgo, y viceversa. Además, nuestros modelos incorporaron un conjunto amplio de variables de control a nivel de estudiante, hogar y escuela, tanto invariables en el tiempo (género, condición de necesidades educativas especiales, número de libros en casa, tipo de escuela) como variables en el tiempo (hábitos de lectura en papel, motivación extrínseca, acceso a dispositivos digitales en la escuela). Al emplear RI-CLPM, pudimos separar la varianza intrapersonal de la varianza entre personas, lo que nos permitió sostener que los caminos recíprocos observados en el CLPM probablemente reflejaban relaciones estables basadas en rasgos entre comprensión lectora y motivación intrínseca. En nuestro estudio, los interceptos aleatorios de estas variables se correlacionaron positivamente, indicando que los individuos que generalmente mostraban mayor motivación intrínseca también tendían a mantener habilidades de comprensión lectora más sólidas a lo largo del tiempo. Estos resultados sugieren que, aunque las fluctuaciones momentáneas en motivación y comprensión lectora pueden no influirse simétricamente, existe una conexión estable y duradera entre ambas a nivel de rasgo. La ausencia de caminos cruzados significativos entre los hábitos de lectura digital, motivación y comprensión lectora a nivel intraindividual desafía las suposiciones direccionales propuestas por el “círculo virtuoso de la lectura” (típicamente aplicado a la lectura en papel), que plantea que los estudiantes con fuerte comprensión lectora se motivan más, aumentando sus hábitos de lectura y fortaleciendo aún más sus habilidades y motivación. La falta de efectos cruzados entre los hábitos de lectura digital y la comprensión lectora coincide con estudios previos (así como con el Estudio 1 de esta

tesis) y refuerza la idea de que la lectura digital puede favorecer un procesamiento superficial. Asimismo, proponemos la idea de que los hábitos digitales podrían desarrollarse cada vez más independientes de la comprensión lectora debido a la creciente integración de la tecnología en la vida cotidiana y escolar.

Finalmente, en el Capítulo 5 se ofrece una discusión que integra los principales hallazgos, destacando la ausencia general de relación entre los hábitos de lectura digital y la comprensión lectora. Las implicaciones educativas de nuestros hallazgos se vinculan directamente al uso de formatos digitales para la lectura. Primeramente, es importante reconocer que la lectura digital forma parte de nuestra vida diaria y que los estudiantes necesitan aprender a desenvolverse en entornos digitales, además de la lectura en papel. Por ello, no se recomienda eliminar la lectura digital de la educación, sino integrarla como una herramienta complementaria que contribuya al desarrollo de la comprensión lectora sin sustituir la lectura impresa. Una de las principales ventajas de la lectura digital es el acceso inmediato a la información. Los estudiantes pueden beneficiarse de actividades que impliquen buscar información en internet, como proyectos de investigación, mientras continúan practicando habilidades de comprensión lectora mediante textos impresos. Aunque la presente tesis se ha centrado en los hábitos de lectura fuera de la escuela, se considera que los centros educativos desempeñan un papel clave en la promoción de prácticas responsables y enriquecedoras de lectura digital que puedan trasladarse más allá del aula. Los hábitos de lectura en papel se han relacionado de forma positiva con la comprensión lectora, especialmente en las primeras etapas educativas, ya que permiten una mayor concentración y reflexión. Sin embargo, los textos digitales, aunque de fácil acceso, suelen carecer de control de calidad y muchas veces presentan un lenguaje informal y contenidos breves, lo que puede dificultar el desarrollo de habilidades lectoras avanzadas y limitar la atención sostenida. Para afrontar estos desafíos, los estudiantes

necesitan orientación estructurada que les enseñe a identificar materiales digitales de calidad, evaluar críticamente las fuentes y navegar de forma segura y efectiva por los entornos digitales. Estas habilidades no son innatas y es un error asumir que los jóvenes las dominan simplemente por haber crecido rodeados de tecnología.

Además, como se ha evidenciado en la presente tesis, el uso de dispositivos digitales puede afectar negativamente la motivación intrínseca hacia la lectura. A diferencia de la lectura impresa, que requiere tiempo y atención plena, la lectura digital suele ser fragmentada, realizada de forma incidental. Muchas veces se limita a consultas rápidas y finaliza en cuanto se obtiene la información buscada. Esto convierte la lectura en una actividad secundaria y automática, asociada a la gratificación inmediata, lo que fomenta un procesamiento superficial de la información. Dado que los dispositivos digitales cumplen múltiples funciones, no siempre se perciben como herramientas para la lectura profunda. Por ello, muchos estudiantes siguen prefiriendo la lectura en papel para textos largos. Para cambiar esta predisposición, los docentes pueden crear espacios de lectura digital con materiales de calidad dentro del aula, promover la creación y el intercambio de contenidos digitales entre estudiantes y enseñar estrategias para reducir distracciones, como el uso de bloqueadores de anuncios o la desactivación de notificaciones. De esta manera, es posible fomentar experiencias de lectura digital más reflexivas y menos impulsivas.

En cuanto a futuras líneas de investigación, resulta fundamental diferenciar entre estudios transversales y longitudinales. Los diseños transversales, como los empleados en el Estudio 1 y 2, muestran asociaciones en un momento específico, pero no permiten establecer relaciones causales. Por ejemplo, que los estudiantes que leen más en digital tengan menor comprensión lectora no implica que la lectura digital sea la causa. En cambio, los estudios longitudinales, como el descrito en el Estudio 3, permiten analizar

cómo evolucionan los hábitos y la comprensión lectora a lo largo del tiempo, identificando influencias recíprocas y ofreciendo una visión más precisa de estas relaciones. En los análisis longitudinales existen diferentes enfoques que pueden producir resultados distintos. En el Estudio 3 se explicó que algunos modelos permiten analizar asociaciones a lo largo del tiempo, pero no establecer relaciones causales, ya que combinan tanto las diferencias estables entre individuos como las fluctuaciones temporales y situacionales. Para superar esta limitación, otros modelos separan estas dos fuentes de variación, identificando por un lado las tendencias estables que se mantienen en el tiempo y, por otro, los cambios que ocurren dentro de cada individuo. Esta distinción fue clave para los objetivos de esta tesis y puede ayudar a reinterpretar resultados de estudios previos. Es posible que investigaciones anteriores hayan mezclado ambos efectos, lo que podría haber dado lugar a una sobreestimación de la relación dinámica entre la comprensión y la motivación lectora. Por ello, se subraya la importancia de emplear diferentes enfoques metodológicos y estadísticos de forma complementaria para comprender mejor la naturaleza de estas asociaciones. En cuanto a la exploración de potenciales factores influyentes, destacamos tres factores del entorno. En esta tesis nos hemos centrado principalmente en el desarrollo de los hábitos lectores, comprensión y motivación lectora, considerando algunas variables ambientales como el nivel de digitalización de los centros educativos, el tipo de colegio y la cantidad de libros disponibles en el hogar. Sin embargo, es necesario profundizar en la investigación sobre los entornos escolar y familiar para comprender mejor las diferencias en la adquisición de hábitos de lectura y en el desarrollo de la comprensión y motivación lectora. Además, debemos tener en cuenta que la tecnología y sus interfaces continúan evolucionando, incorporando nuevas funciones y características físicas que pueden influir en la forma en que leemos y, por tanto, redefinir nuestra comprensión de la lectura.

Otra limitación de este trabajo es que los hábitos de lectura se han medido únicamente en términos de frecuencia, solicitando a los estudiantes que indicaran cuánto leían una lista reducida de contenidos digitales. Futuras investigaciones podrían emplear herramientas de medición más detalladas (p.ej., herramientas tecnológicas), que permitan medir la frecuencia lectora de manera objetiva y tengan en cuenta la diversidad de materiales leídos y la profundidad de la interacción con ellos. Asimismo, sería relevante explorar estas relaciones en diferentes etapas educativas y contextos culturales, con el fin de obtener una visión más completa del papel que desempeñan los hábitos de lectura digital en la comprensión y motivación lectora.

En conclusión, la digitalización ha transformado los hábitos de lectura y ha generado nuevos retos para la educación. Integrar de forma equilibrada la lectura digital y la impresa, ofreciendo orientación y espacios adecuados, es esencial para desarrollar tanto la comprensión lectora como la motivación hacia la lectura en la era digital.



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