



# Is the home literacy environment different depending on the media? Paper vs. tablet-based practices

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## Abstract

The Home Literacy model predicts different outcomes depending on formal and informal literacy practices carried out at home. However, this model does not explicitly consider the potential differences that the media (paper vs. tablets) in which these practices are carried out can have on performance. The present study explored this issue. Participants were 136 children aged 6–7 years old and their parents. The different activities performed at home were analysed through reports of the parents, and children were assessed at school for their reading performance (decoding and comprehension). Results showed how formal practices using traditional materials predicted reading comprehension, but informal practices did not predict any performance measure. The digital home literacy environment showed no impact on reading performance, suggesting that two different environments (paper and digital) might exist, each one of them having differential impacts on performance. Implications for research and education are discussed.

**Keywords** Home literacy environment · Reading performance · Paper-based literacy · Tablet-based literacy · Primary school children

Home literacy practices play an important role in developing children's reading skills (Sénéchal & LeFevre, 2002). Evidence also suggests that the use of touch-screen tablets at home is related to higher literacy skills (Neumann & Neumann, 2017).

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However, not many studies compare the impact of home literacy practices in different media (printed vs. tablet) at the same time on children's literacy performance (e.g., Neumann, 2016; Segers and Kleemans, 2020). Also, how to measure reading achievement also varies between studies: letter recognition (Kotrla Topić et al., 2020), letter knowledge and oral comprehension (Rvachew et al., 2017), reading fluency and vocabulary (Silinskas, Sénéchal et al., 2020), print awareness and print and sound knowledge (Neumann, 2016), or reading comprehension and metacomprehension (Halamish & Elbaz, 2020). Therefore, more research is needed to fully understand the impact of home literacy practices in children's reading achievement. If different media happen to have differential effects on children's reading development, it would affect how we approach home literacy and which practices should parents promote when interacting with their children. To this end, a within-participant study would be most appropriate, in which children using both printed materials and tablet devices are analysed to better understand how different media can affect their performance.

## Literature review

### Home literacy model

The home literacy model (Sénéchal & LeFevre, 2002) suggests that children are exposed to different types of literacy activities at home. These activities can be categorized as formal and informal: formal activities focus on print as the primary goal of the task (like teaching letters or spelling), while informal activities, even if they use print, do not focus on the print itself (like shared reading, where the focus is on the story and events contained in the print, or playing games where print is present but it is not the main focus of the game).

The home learning environment of preschool children is not only related to literacy precursors at that age, but also to children's competencies several years later (Niklas & Schneider, 2017). However, according to the home literacy model, those competencies are different depending on the type of activities (formal or informal) performed at home (Sénéchal, 2006; Sénéchal & LeFevre, 2014): as it will be reviewed next, formal practices are usually related to written competencies, while informal practices are to oral-based competencies. Some written competencies commonly investigated are decoding, print knowledge or spelling, while oral-based competencies is the term often used to include skills such as vocabulary or reading comprehension.

Also, age seems to be a factor influencing which competencies are promoted by the different home literacy activities. For example, informal practices are associated with oral competencies (such as receptive vocabulary or reading comprehension) while formal practices correlate with written competencies (such as word decoding or reading fluency) in Grades 1 and 4 (Sénéchal, 2006; Sénéchal & LeFevre, 2014). However, at different ages (Grade 3), both formal and informal practices are related to oral competencies like vocabulary and comprehension (Sénéchal & LeFevre, 2002). Other longitudinal studies suggest that both formal and informal practices contribute indirectly to decoding in Grade 1, and this skill mediates the effect on reading comprehension in Grades 2 and 3 (Inoue et al., 2018). Also, formal literacy activities at

preschool have been showed to indirectly associate with reading comprehension in secondary school (Lehrl et al., 2019).

Although it is widely accepted that home literacy practices have an impact on children's competencies, it is important to highlight that some studies did not find that relationship. For example, home literacy activities (reading/writing letters, games that use letters, repeating songs with rhymes, reading or telling stories) were not related to literacy predictors (phonological awareness, letter knowledge or vocabulary) in 5-year-olds (Bonifacci et al., 2021). Other studies agree that formal literacy practices are related to children's written-based competencies, but fail to find any relationship of informal literacy practices with either written or oral based literacy competencies (Puglisi et al., 2017). Finally, the opposite of this latter result has also been found: formal literacy practices having no effects on children's written-based competencies (print knowledge) but informal literacy practices having an impact on oral (vocabulary) competencies (Napoli & Purpura, 2018). This same result was obtained with older children and different performance measures: formal practices not having an impact on any measure (reading fluency and reading comprehension), but informal ones having an impact on oral-based competencies such as reading comprehension (Khanolainen et al., 2020). The authors hypothesize that this result might be exclusive in the context of transparent languages, which are faster and easier to acquire by children and, therefore, improvements from home teaching are small and not that relevant (Silinkas, Torppa et al., 2020). Similar arguments are offered by Manolitsis et al. (2011), stating that from Grade 1 on, a transparent orthography is a protective factor that reduces the potential advantages derived from rich home literacy environments. Regarding this issue on the different degrees of orthography transparency, Inoue et al. (2020) analysed home literacy practices in 4 countries with different languages (English, Dutch, German and Greek). They did not find the expected impacts depending on the degree of transparency of the language, but they did find significant differences across the different languages. For example, formal practices were related to letter knowledge and phonological awareness only in Dutch and Greek, and informal practices were not associated with any cognitive or early literacy skills in any of the languages. So there might be other variables, apart from orthographic transparency of the language, that play a role on the impact of home literacy practices that vary across different cultures.

As we can see, previous research offers contrasting results in the topic, and different effects are found depending on children's age or the degree of orthographic transparency of the language. Nowadays, reading practices at home are changing, combining digital and paper materials. However, whether there is a differential effect across media in how reading develops at home is largely an open issue. Also, general reading achievement has been considered very differently across studies, with general reading scores being the most common. This might explain the contrasting results in previous research. Therefore, more research is necessary to increase the knowledge on these issues to extend our current knowledge on home reading practices, using more specific performance measures (reading speed/accuracy and comprehension) to deepen our knowledge on the topic.

## Home tablet use and reading literacy

The presence of tablets at home is growing to the point that they are the most popular devices among young children (Chaudron et al., 2018). Knowing if different media has a differential impact on children's reading skills is of key importance to properly support their reading development at home more efficiently, choosing the specific media that proves to be more useful for each specific skill. The Home Literacy Model does not make a difference between media, that is, it focuses on formal and informal practices but it does not suggest that those practices might have different outcomes depending on the materials involved (printed vs. electronic). However, different media can have significant differential impacts on children's performance (e.g., Delgado et al., 2018; Tingir et al., 2017; Torppa et al., 2020), so formal and informal practices using electronic devices (tablets) should also be considered and reviewed separately.

Previous research on the use of tablets is diverse (e.g., Dore et al., 2018; Rvachew et al., 2017): some studies replicate the results obtained with printed materials and others show important differences between both. Therefore, literacy practices at home should not be considered equal regardless of the media (printed vs. tablet) until more consistent findings are obtained.

On the one hand, several studies report a positive general impact of using mobile devices on pre-schoolers' learning and development (e.g., Herodotou, 2018). Using the tablets to write, for example, is found to be related to print knowledge, such as knowing where a text begins or the left to right directionality in children aged 2–4 years (Neumann, 2016), which are common predictors of decoding. Even some studies suggest that emergent literacy is fostered to a greater extent by e-book shared reading with an adult than by print book shared reading at 5–6 years-old, especially for children with lower skills (Rvachew et al., 2017). E-books also offer some new possibilities to increase children's independence, as experimental data suggest that independent e-book reading by preschool children (where the e-book offers an audio narration) produces similar effects than the reading of printed books by an adult (de Jong and Bus, 2004; Korat and Shamir, 2007), fostering linguistic comprehension. Therefore, 2–5 year old children not only improve their emergent literacy skills using tablets, but they can do so independently and potentially more stimulated and engaged than using printed materials (Neumann, 2018).

On the other hand, however, despite all the potential benefits for learning that tablets can offer, authors still warn about the generalizability of evidence being limited, stating that more research is needed (Haßler et al., 2016). In fact, not all findings agree with the beneficial effects of using ICT, since e-books are not more effective than printed books in several occasions: there are reports suggesting that digital reading hinders children's comprehension compared to reading printed text (Halamish & Elbaz, 2020; Støle et al., 2020). Other studies still find that reading with an adult is superior, in terms of children's (3–5 years old) recall, than e-book audio narrations (Dore et al., 2018; Reich et al., 2019). Also, writing with pencil and paper seems to lead to better literacy performance than using the virtual keyboard on a tablet device (Mayer et al., 2020).

These contrasting results might be explained by how tablets are used: children can use them as a TV replacement (considered negative for learning) or as a book replacement (considered positive), so the different uses should have very different impacts on children's performance (Huber et al., 2018). Furenes et al. (2021) also offer some light on this issue, showing how paper books are only superior when the digital version was just that (a digitization of the printed book), but when the digital books are enhanced using the capabilities of this medium they lead to better performance than paper books. Therefore, it might not be a problem of the media, but of how each media is designed.

These results suggest that media per se might not be that important for children's performance, it is just the behaviours of both children and parents during storybook reading what may vary depending on the platform they are using (Lauricella et al., 2014). Similar conclusions were obtained by Meng (2021), confirming that the direct effect of informal practices on emergent literacy and oral language outcomes are mediated by behaviours of both parent and children during the parent-child interactions. Therefore, even if formal or informal practices are the same (same words, books, same parent/child dyad) these activities can have very different outcomes depending on the media (print or tablet) used.

Despite all these results, previous research analysing different media from the theoretical perspective of the home literacy model is extremely scarce. Only a recent study by Segers and Kleemans (2020) hypothesized the existence of a digital home literacy environment that would be different from the traditional (print) one. Their results supported this possibility, since only the analogue environment was related to pre-schoolers' language abilities. The potential existence of differential home literacy environments (traditional and digital) deserves more attention.

In summary, research on home tablet use is mainly focused on pre-schoolers (2–5 years old), analysing the impact of tablets on basic emergent skills, such as print knowledge or understanding of basic concepts (de Jong and Bus, 2004; Neumann, 2016; Rvachew et al., 2017) and previous findings are mainly based on English speaking population, which is a non-transparent orthography. In order to widen the scope of previous research, the present study focused on primary school children (6–7 years old) in a transparent orthography (Spanish) and measured more advanced literacy skills, such as decoding (accuracy and fluency of word reading) and reading comprehension, taking into account both media: print and tablet.

## The spanish context

Most of the studies published on Home Literacy Environment have been developed in English (see Dong et al., 2020). Therefore, it is important to provide some context about the Spanish educational system and family practices in that country.

The Spanish education system is free and compulsory from age 6 to 16. The pre-school stage from 3 to 6 years of age is free (but not compulsory) for all citizens. This has contributed to the fact that practically all children of these ages (over 95% according to data from the Spanish Ministry of Education; Ministerio de Educación, 2022) are enrolled in school. From 6 to 12 years of age, they attend the Primary Edu-

cation stage, where 5 h of class per day are taught with special emphasis on Language and Literature (1 h per day) and Mathematics (another hour per day).

Regarding the involvement of Spanish families in their children's education, there are few studies that explore family support in the first years of Primary Education. Some data affirm that the vast majority of parents help their children to prepare school material for the next day at this age (85.3%), establish a fixed place within the home to do academic homework (83.33%), and review daily (81.2%) or frequently (16.6%) their schoolwork (Gil Madrona, 2009). The data reported by the children themselves in this study when answering the same questions were similar to those provided by their parents. Other studies show similar results, with 79.6% of parents stating that they collaborate with their children in schoolwork (Martín et al., 2005). However, in this study the perception of the children themselves is much lower (only 45.4% agreed that their parents frequently collaborated with them in their homework). It is possible that this is due to the fact that this study considered the entire Primary school stage (6–12 years of age), not only the first years. Gil Madrona (2009) shows in his data how this parental involvement decreases as the child progresses through the grades, falling to 37.3% in the last grades of Primary school. When teachers are interviewed, their perceptions of parental involvement in Spain follow the same line of results: it is felt that the majority of their students' parents (over 70%) are involved in their children's academic development (Fernández-Freire Álvarez et al., 2019).

In summary, most parents in Spain are involved in their children's school activities during the primary school stage, supporting their children's academic development from home.

## The present study

The present study aimed to investigate the types of home literacy activities performed using print-based and tablet-based materials and the associations that these activities have with reading performance. The research question and hypotheses of this study were:

Do formal (teaching writing and spelling) and informal (shared reading) home literacy practices have a differential impact on children's performance (decoding and comprehension) depending on the media (print vs. tablet)?

First of all, it is expected to find that formal and informal practices have a differential impact on performance (H1), as suggested by the Home Literacy model (Sénéchal & LeFevre, 2002). More specifically, following Khanolainen et al. (2020) it is expected that formal practices using printed materials have no impact on either reading fluency or reading comprehension, but informal practices should be beneficial for reading comprehension. Transparent orthographies are simpler to learn for children, so home practices are not that necessary to obtain benefits in that context (Silinskis, Torppa et al., 2020). Since Spanish is also a transparent orthography, these results should be replicated in our sample.

Second, it is expected to find a differential impact between the traditional (print) and the digital (tablet) home literacy environments (H2). As suggested by Segers and Kleemans (2020), print and digital practices should have differential impacts on chil-

dren's performance. Regarding formal practices using tablet devices, previous studies show a beneficial impact on emergent literacy (Neumann, 2016), so this would pose a different impact than the expected for the traditional environment. Considering now informal practices (reading e-books), and contrary to the expected outcomes on traditional media, no positive impact on performance is expected to be found (Halamish & Elbaz, 2020; Støle et al., 2020).

## Method

### Participants

In the study participated 136 children (47% girls, 53% boys) aged 6–7 years old (1st Grade of Primary school, or Elementary school in other countries) and their parents. Students with learning disabilities or special needs were not included. All children attended schools situated in neighbourhoods with a medium socioeconomic status in Spain, and all of them spoke Spanish as a first language. Parent educational level was categorized using ISCED-97 scale (UNESCO, 1996), considering three levels: low (ISCED 0–2) with 5.9% of parents, medium (ISCED 3–4) with 17% of parents, and high (ISCED 5–6) with 55.1% of parents. The rest (22%) did not report their educational level.

### Measures

**Reading Performance:** A validated scale for Spanish population (PROLEC-R by Cuetos et al., 2007) was used. Specifically, students were assessed on word decoding (amount of words correctly read from a list and time taken to read the complete list of 40 words), and reading comprehension (amount of correct answers given to 16 questions about 4 different texts). Cronbach's alpha reported by the scale was 0.74 for the word reading test and 0.72 for the comprehension test. The variables included in the model were "Decoding" (amount of correct words read divided by the time taken to read them) and "Reading comprehension" (amount of correct answers given to the comprehensions questions).

**Home Literacy Practices:** Measuring children's cognitive experiences at home through parental reports has been proved to be reliable (Dreyer et al., 1996), so this method was used for the present study. Parents completed an adapted questionnaire that has been successfully implemented in previous research (Neumann, 2016). They were asked to report the frequency of formal activities carried out by the children at home using the tablet (how often they used the tablet with their child to write and type) and the frequency of informal activities on that device (how often they read e-books on the tablet with their child). They also reported the frequency of formal activities on printed materials (how often they engaged in writing with pencil and paper with their child) and informal activities on this medium (how often they shared reading of printed storybooks with their child). Therefore, following Sénéchal and LeFevre (2014) writing activities (either on tablet or paper) in which the child must focus on print as the main goal were considered as formal practices, and reading

story-books, in which the child is focused on the storyline were considered informal. All items were reported using a Likert scale, being 1=*never*, 2=*monthly*, 3=*every two weeks*, 4=*weekly*, 5=*daily*, and 6=*several times a day*. The four items in the Home Literacy Questionnaire can be found in Appendix 1.

## Procedure

All children were assessed for reading performance at their respective schools, after obtaining informed consent from their parents and permission from the schools. The assessments of the decoding task were carried out to every child individually by a researcher using PROLEC-R (Cuetos et al., 2007). This same scale was used to assess reading comprehension, this time in group (each child in their respective classroom), accompanied by a researcher and their school teacher. The research followed the ethical guidelines of the Declaration of Helsinki, as well as those prescribed by the university.

The home literacy practices questionnaire was completed by parents at home. The schools were in charge of sending and collecting the questionnaires to those parents who signed the informed consent. Both assessments were performed using printed materials.

Structural equation modelling was used to analyse the results. A model was created based on expected interactions according to previous research. This model was tested using the diagonally weighted least squares (DWLS) method that is recommended for data that do not fit a normal distribution. Results were discussed in light of the significant and non-significant path coefficients that were obtained.

## Results

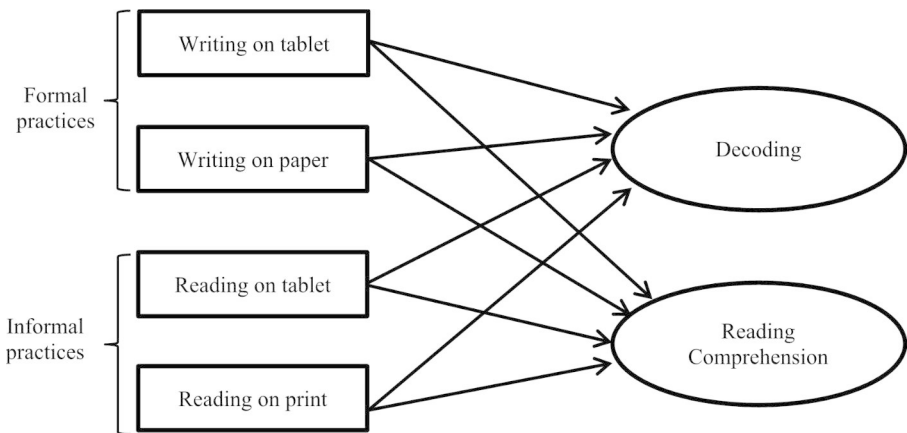
### Descriptives of home literacy activities

From the initial 136 participants some were excluded because they did not own/use tablet devices at home, they did not complete all assessments or did not give consent for the study. The final sample was composed by 118 participants. Descriptives for the activities performed by children at home using tablets are shown in Table 1. Children are more frequently engaged in home literacy practices (both formal and informal) that make use of printed materials compared to the frequency of those practices involving tablet devices.

**Table 1** Descriptive Statistics for Home Literacy Activities (N=118)

Measures	Mean	SD	Min	Max	Skewness	Kurtosis
Formal activities						
Writing on tablet	3.19	1.55	1	6	-0.122	-1.067
Writing on paper	5.32	0.54	4	6	0.081	-0.716
Informal activities						
Reading e-books on tablet	1.59	1.19	1	6	2.051	3.490
Reading printed storybooks	4.95	0.61	2	6	-1.117	4.750





**Fig. 1** Tested model on the impact of formal/informal practices and paper/digital materials on reading performance

**Table 2** Goodness of Fit Indices

Indices	Acceptable Value*	Obtained value
Model $p$	>0.05	0.163
$\chi^2/df$	<5	1.47
GFI	>0.90	0.970
RMSEA	<0.08	0.063
SRMR	<0.08	0.066

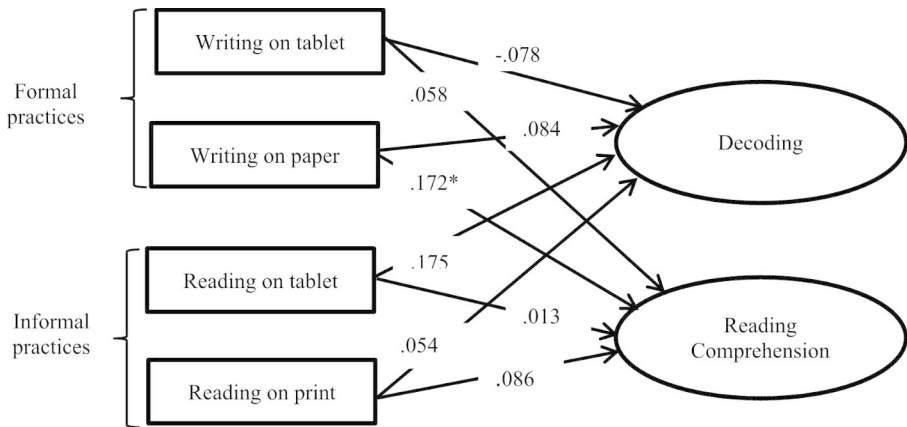
\*Note: based on Kline (2010) and Galindo-Domínguez (2019)

### Structural equation modelling (SEM)

Figure 1 shows the tested model of the impact of home literacy practices on reading performance. Since previous studies are inconsistent in their findings, both formal and informal practices (in both media) were related to the dependent variables to fully assess which ones are significantly relevant. Also, these interactions were studied within-participants, to obtain more reliable results indicating potential differences across media (print vs. tablet) or across practices in each media (formal vs. informal). Dependent variables are not allowed to correlate by default in SEM, but independent variables were allowed to correlate within categories: formal practices (writing on tablet and writing on paper were allowed to correlate between them) and informal practices (reading on tablet and reading on print were allowed to correlate between them).

Since some variables were measured at an ordinal level (Likert scale) and data was not normally distributed (as indicated by Kolmogorov-Smirnov test,  $p < .05$ ), the diagonally weighted least squares (DWLS) method was used. Chi square for the model was  $\chi^2 = 11.750$  and goodness of fit indicators were appropriate (see Table 2). It is worth noting that the GFI does not rely on sample size (Kline, 2010), so the goodness of fit of the model is good despite the relatively small sample for the study.

Figure 2 shows the standardized parameter estimates for the model. Decoding skills were not significantly affected by medium (print vs. tablet) or type of home



**Fig. 2** Significant Standardized Estimates for the Tested Model (Note: \* $p < .05$ )

practices (formal vs. informal). However, reading comprehension performance was significantly related to formal practices, but only using printed materials. Those formal practices had no effect on the tablet-based setting. Therefore, results show a differential impact of medium for this outcome measure.

## Discussion

The present study aimed to investigate the following research question: Do formal (teaching writing and spelling) and informal (shared reading) home literacy practices have a differential impact on children’s performance (decoding and comprehension) depending on the media (print vs. tablet)? Two hypotheses were examined:

**H1** it is expected to find that formal and informal practices have a differential impact on performance.

As suggested by the Home Literacy model (Sénéchal & LeFevre, 2002), formal and informal practices should promote different literacy skills. The results obtained in this study support, in part, the Home Literacy model: formal practices were related to reading comprehension while informal practices were not. This result contrasts with previous studies, in which formal practices had an impact on written-based (decoding) and not oral-based (comprehension) competencies (Sénéchal, 2006; Sénéchal & LeFevre, 2014). But this result supports the study by Lehl et al. (2019), which also found how formal practices could promote reading comprehension.

The lack of effect of informal practices on any of the performance measures is against the Home Literacy model, which suggests that informal practices are related to oral based competencies, such as vocabulary and comprehension (Sénéchal, 2006; Sénéchal & LeFevre, 2002, 2014). However, this is not an isolated result: previous findings (Inoue et al., 2020) have reported a lack of impact of informal practices on any cognitive or early literacy skills, regardless of the orthographic transparency of

the language. Different performance measures across studies might explain these differences: decoding, comprehension, vocabulary or print knowledge are just some of the variables that are considered to assess reading achievement. However, all these measures are very different and they are bound to be impacted differently by formal and informal practices. Training specific decoding skills (which happens in formal practices) is probably more related to specific skills of reading speed and accuracy. In more general settings (informal practices) it is understandable that more unspecific skills might be developed, less important to decoding but more related to comprehension. Therefore, how we approach the assessment of reading performance may cause different results. This is why it is important to avoid global performance measures and start analysing these issues using several specific measures at the same time.

**H2** it is expected to find a differential impact between the traditional (print) and the digital (tablet) home literacy environments.

Segers and Kleemans (2020) suggested the possibility of a digital home literacy environment that could be distinguished from the traditional one. In line with their results, the present study supports that claim and in the same direction: only the traditional home literacy environment seems to be related to literacy performance. It is important to highlight that this conclusion is the same in both studies despite the different age of the sample and the different performance measures analysed in each study. It is also worth noting that the digital literacy practices were much less frequent than the traditional ones in the present study. This might have had an influence on the lack of impact of those practices.

However, this result goes against a large body of literature that, even though is not framed under the Home Literacy model, is comparable in some aspects. Many positive effects of using tablets have been found in previous research: using the tablets to write benefits emergent literacy skills (Neumann, 2016), emergent literacy is greater fostered by e-book shared reading with an adult than by print book shared reading (Rvachew et al., 2017) or e-books also offer some new possibilities to increase children's independence producing similar effects than the reading of printed books by an adult (de Jong and Bus, 2004; Korat and Shamir, 2007), are results that contrast very strongly with the lack of effect of a digital home literacy environment. It is also possible that parenting style plays a role: some parents do not control screen time properly and do not promote enough reading practices, which causes that high frequency of tablet use correlates to lower parent storytelling frequency (Chen et al., 2020). Also, it is commonly agreed that quality of technology use is more important than quantity (Lei, 2010), so the common frequency reports that are used in this type of studies might not be the best option to fully assess the situation. A parent can use tablets to share storybook reading with their children every day, but the quality of that interaction might be more important than the frequency of it (Lauricella et al., 2014; Meng, 2021). Another issue, highlighted by Furenes et al. (2021) is that digital materials often mimic the traditional ones, negatively affecting their impact. But if digital materials are properly designed, they could foster a higher performance than traditional ones, so the quality of these materials should also be taken into account. A final issue to consider is that results might be very different depending on the age of

the sample that is being investigated. Children age has an influence on parents' perceptions on digital media use at home (Kucirkova et al., 2018), which may be a contributing factor that helps explain these contrasting results across different studies.

## Conclusions

The present study partially supports the Home Literacy model (Sénéchal & LeFevre, 2002), supporting the claim of a differential impact of formal and informal home literacy practices on children's performance. However, the lack of impact of informal practices on any performance measure suggests that more research is necessary to fully understand how these practices impact performance. Also, this study supports the only claim available on the possibility that a digital home literacy environment can be distinguished from a traditional one.

## Limitations and future research

The present study has some limitations that must be highlighted. First, sample size should be greater to facilitate the generalization of the results. Studies with much lower samples than the one used in the present study are common in the field (e.g., Lauricella et al., 2014; Neumann, 2016; Segers and Kleemans, 2020), signaling the difficulty of studying these issues in such a young population, and also the validity and importance of the results obtained in a field of study that needs more research. However, larger samples will be beneficial to better understand the extent of the relationships reported. Second, self-report questionnaires, despite their common use in research, are affected by social desirability of respondents, which may influence the results obtained.

Second, the study used a cross-sectional design. The fact that participants were assessed only once for each variable at a particular point in time is a major limitation. More effort should be put into longitudinal studies in order to obtain more complete and reliable information on this issue.

Third, frequency measures were used to assess formal and informal practices, which might offer an incomplete view of the issue. In the present study, parents reported that their children read and wrote more frequently using printed materials than on the tablet. This may cause lower sensitivity on some measures or interactions. Furthermore, the questionnaire employed, although it has been applied in previous research, does not have information on reliability and validity. Future research may be able to study these issues gathering more objective data, keeping in mind that interfering with the home environment using cameras, recorders, or the presence of researchers would also be problematic.

Finally, the quality of the materials needs to receive better attention, as well as the quality of the parent-child interactions, since they might have an important influence.

The amount of devices, applications, materials, assessments and activities that can be performed in electronic mediums is great, so more extensive research is necessary to analyse and gather information on the different effects that different combinations may have on performance. This wide variety of variable combinations causes that

results from research in this topic are very difficult to generalize. Institutions and families should be very careful on how to implement and use these technologies in order to obtain benefits from them. The specific device, app, frequency of use, age of the user or performance measures are just some of the key elements that should be considered, rather than general recommendations, to have an efficient and fruitful experience using these devices.

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## Declarations

**Conflict of interest** The authors declare that they have no competing interests in this work, that this is an original research which has not been published before and it is not under concurrent consideration elsewhere.

**Ethics approval and consent to participate** The research followed the ethical guidelines of the Declaration of Helsinki, as well as those prescribed by the university. Parents of all participants signed an informed consent and participant schools approved the development of the study.

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