

Case Study 1: An Evidence-Based Practice Review Report

Theme: School/setting Based Interventions for Learning.

How effective are e-books at promoting vocabulary acquisition in emergent readers?

1.1 Summary

E-books enable children to access stories in an electronic format with a wide range of features that are not available from printed books. Features such as animations, sound effects and interactive dictionaries are designed to engage the reader and draw their attention to specific aspects of the story or text. These features have the potential to facilitate learning and improve a child's vocabulary. Therefore, as vocabulary is a key emergent literacy skill that facilitates the development of reading, writing and comprehension skills it is important to establish if e-books help or hinder vocabulary learning.

This systematic literature review identified six studies to evaluate the effectiveness of e-books on promoting vocabulary acquisition in young children with emergent reading skills. Following an in-depth evaluation, there was not sufficient evidence due to a range of limitations in the studies reviewed to support the effectiveness of e-books in promoting vocabulary acquisition.

1.2 Introduction

1.2.1 Digital storybooks - E-Books

In the United Kingdom, young children are becoming increasingly prolific consumers of technology-based media with 24% of three to four-year olds owning a tablet and 37% of five to seven-year olds (OfCom, 2019). Similarly, technology is increasingly being used in schools

to promote learning (Moody, 2010) with the Government actively encouraging schools to embed technology into their everyday teaching practice (Department for Education, 2009).

One impact of tablet ownership is that many young children are now able to access stories via e-books (Burnett, 2010). For this review, e-books are defined as stories available in an electronic format on a computer, tablet or dedicated e-book reader (Subba Rao, 2003; Zucker, Moody, & Mckenna, 2009). One of the key benefits of e-books is that they provide a range of additional features not available in printed books (Bus, Takacs, & Kegel, 2015; Roskos, Sullivan, Simpson, & Zuzolo, 2016; Zucker et al., 2009). Through hypermedia e-books can bring a story to life, providing an optimal match between verbal and visual information with the potential to facilitate learning (Mayer, & Moreno, 2003; Salmon, 2014; Zucker et al., 2009). However, there is limited evidence regarding their effectiveness to promote learning (Sari, Basal, Takacs, & Bus, 2019; Zucker et al., 2009)

Some features, such as questions and hotspots which provide explanations of words, are purported to mimic the shared interactions seen in reading where an adult would scaffold learning for a child (Korat, & Shamir, 2007). There is evidence to suggest that these can be beneficial in improving in young children's literacy skills (Korat, & Or, 2010; Korat, Levin, Ben-Shabt, Shneur, & Bokovza, 2014; Shamir, & Korat, 2007). However, some research suggests that the need for children to switch between tasks when reading makes them detrimental to learning (Bus et al., 2015). Other features such as background music and sound effects have also been found to detract from a child's ability to understand the text or follow the story (Richter, & Courage, 2017). One consistent finding of research is that the more congruent learning features are with the story, the more they enhance literacy skill development (de Jong & Bus, 2003; Salmon, 2014).

1.2.2 Psychological basis

The term emergent literacy is used to qualify the broad range of behaviours and skills that are developing concurrently and often independently of any formal teaching in young children (Dickinson, & Porche, 2017). Reading is considered to be one of the fundamental and critical emergent skills which enables children to engage successfully in education and society (Dickinson, & Neuman, 2011).

The empirically supported Simple View of Reading Model (Gough, & Tunmer, 1986) conceptualises the relationship between the component skills for emergent reading. These skills are decontextualized language skills, vocabulary, knowledge of letters, phoneme-grapheme correspondence skills and knowledge about conventions of print. The model postulates an interdependency between oral language and both reading ability and comprehension. Research has found that two key aspects of oral language, namely expressive and receptive vocabulary have a multi-faceted positive correlation with reading skills which extends beyond phonology (Ouellette, & Beers, 2010; Vellutino, Tunmer, Jaccard, & Chen, 2007).

However, while research has found that oral vocabulary is directly and positively correlated to reading comprehension in older students, for younger students measures of oral vocabulary are more closely related to their current listening comprehension ability (Ouellette & Beers, 2010). This is partly explained by younger children's reliance on decoding skills when reading and the discrepancy between the breadth of their vocabulary knowledge (the number of phonological entries) and their depth of vocabulary knowledge (the meaning of words) (Ouellette, 2006).

Research has found that the breadth of receptive vocabulary knowledge is positively correlated to decoding skills and explains the relationship between oral vocabulary and reading skills. It

is suggested that phonological representations of words are encoded into a child's lexicon to enable decoding prior to semantic knowledge being added. As a result, young children's reading skills do not reflect their comprehension ability. However, the process of reading engages children with the semantic element of words already encoded into their lexicon, facilitating an increase in the depth of their vocabulary knowledge (Ouellette, 2006).

Due to this symbiotic relationship between language and reading, early educational experiences are able to significantly influence the development of emergent literacy skills in young children through the use of language and reading activities. Features that support understanding of the text can improve vocabulary even after only one reading (Elley, 1989). In addition, methods that scaffold children's learning by highlighting contextual links between text and illustrations and improve word recognition can also support understanding and learning (Biemiller, & Boote, 2006). Therefore, e-books could either improve an emergent reader's learning (Segers, & Verhoeven, 2002) or could distract them from learning (Kozminsky, & Asher-Sadon, 2013).

1.2.3 Rationale for Review

The importance of every child developing vocabulary as part of functional literacy skills is evidenced in the UK Government's National Curriculum Strategy for English (Tonkin, & Wilkinson, 2010). Data shows that higher literacy skills are associated with higher employment, higher wages, improved long term health and a reduced risk of homelessness, particularly for women (Morrisroe, 2014).

A key role for Educational Psychologists (EPs) is in supporting schools and parents to use effective strategies to promote young children's emergent vocabulary skills (Bartram, & Wolfendale, 1999) as these have been found to be inextricably linked to long term literacy levels (Hemphill, & Tivnan, 2008). Therefore, due to their wide spread availability in pre-

schools and early years school settings (Bus et al., 2015; Connor et al., 2019), it is pertinent that Educational Psychologists have a clear understanding of the empirical evidence around the effectiveness of e-books on vocabulary acquisition in young children. This systematic review aims to identify, synthesise and evaluate the current research on e-books and create a comprehensive answer to the following review question:

How effective are e-books in promoting vocabulary acquisition in young children with emergent literacy skills?

1.3 Critical Review of the Evidence Base

1.3.1 Literature Search

A search of the literature was conducted on January 11th, 2020 using the databases and search terms listed in Table 1.1. All searches were conducted with 'peer-reviewed journals' and 'written in English' as search criteria and all terms were searched under 'all fields'.

Table 1.1

Online Database Search Terms

Database searched	Key Concepts & Alternative Terms	Search Terms	
		Children	Condition
ERIC (EBSCO) PsycINFO	"e-book" OR "Animated book" OR digital storybooks OR electronic books	preschool OR kindergarten OR early childhood education OR elementary school OR primary school	vocabulary OR literacy OR language OR reading
SCOPUS Web of Science Google Scholar		AND	AND

Out of the 250 papers found, 61 were excluded as duplicates. The remaining studies were screened by title using the inclusion and exclusion criteria in Table 1.2. This removed a further 143 studies, leaving 46 to be screened by abstract. The final 17 studies were then screened by full text and a further 12 excluded (Appendix 1A, Table 1.7 lists the studies excluded at abstract and full screening with rationale). The remaining 5 studies listed in Table 1.3 were included in the systematic review (Appendix 1B, table 1.8 lists the key information for these studies). Ancestral searches of these papers found a further 4 studies which all were excluded from the final review. Figure 1.1 shows a flow chart of the literature search process.

Table 1.2*Inclusion and Exclusion Criteria Used to Select Studies for the Review*

	Criterion	Criteria for Inclusion	Criteria for Exclusion	Rationale
1	Research design and methodology	The study has used an experimental group-based design with pre and post measures from primary data.	The study has not used an experimental group-based design with pre and post measures from primary data.	To allow the reviewer to critically assess the effectiveness of the intervention and calculated and compare effect sizes across studies.
2	Type of article	The articles must be in a peer reviewed journal.	The articles were not in a peer reviewed journal.	To ensure studies have been subjected to scrutiny and are of a high calibre.
3	Measures	Outcome of the study must evaluate pre & post measures of vocabulary.	The study does not evaluate pre & post measures of vocabulary.	To ensure that the studies relate to the primary focus of the research question.
4	Participants	The study involved typically developing children between 4 – 7 years old.	The study did not involve typically developing children between 4 – 7 years old.	To ensure that all participants were developing emergent literacy skills and did not have any specific learning need.
5	Intervention/ condition	The intervention used an electronic book in a school or educational setting.	The intervention did not use an electronic book in a school or educational setting.	To ensure that the studies relate to the research question.
6	Language	The study was run in a language that has a high genetic proximity to English.	The study was not run in a language that has a high genetic proximity to English.	To ensure that the syntax, morphology, phonology and lexicon of the language are sufficiently related to English to enable findings to be generalised to UK schools.
7	Setting	The study has been conducted in the USA or an EU country with an early year's education program comparable to the UK.	The study has not been conducted in the USA or an EU country with an early year's education program comparable to the UK.	To ensure that review findings are applicable to UK school populations.

Figure 1.1: Flow chart illustrating the literature search conducted

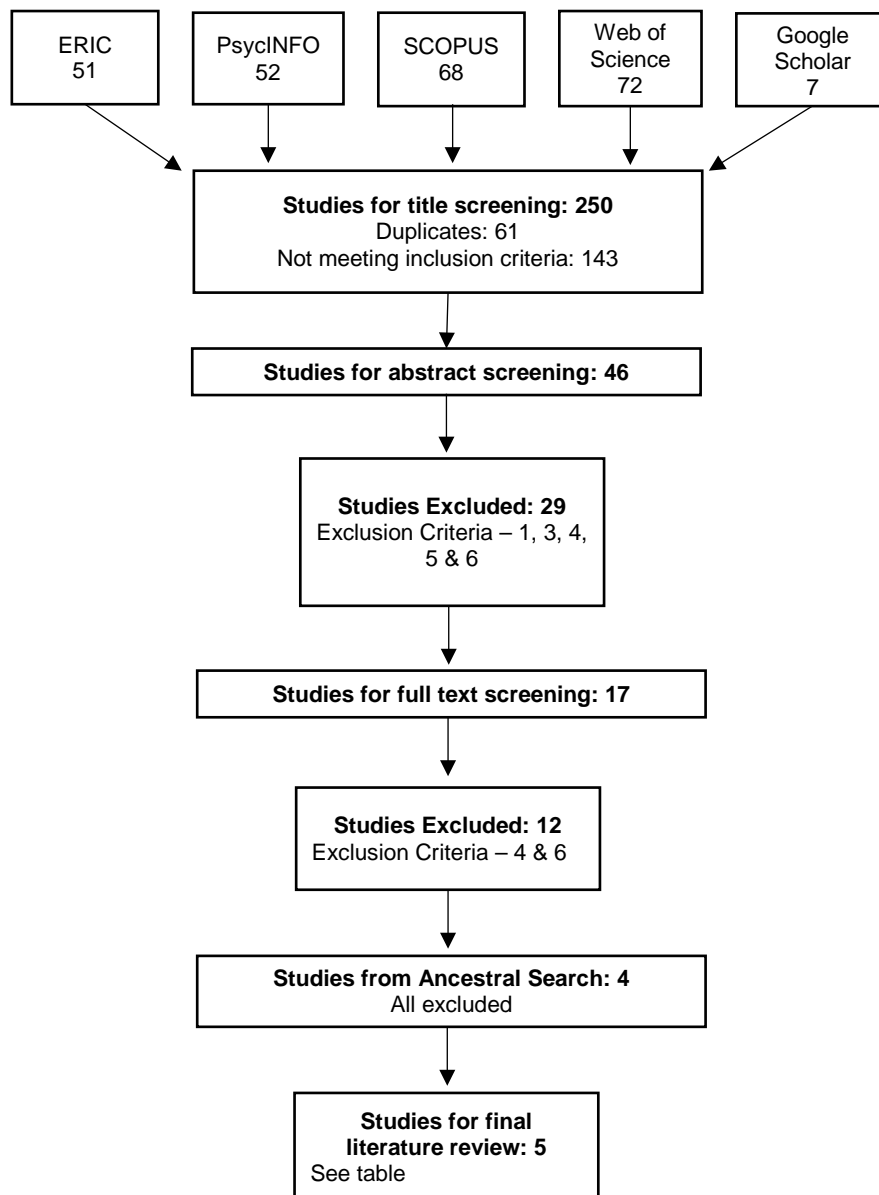


Table 1.3

Studies Included Within This Review

Study Reference

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1. Broemmel, A. D., Moran, M. J., & Wooten, D. A. (2015). The Impact of Animated Books on the Vocabulary and Language Development of Preschool-Aged Children in Two School Settings. *Early Childhood Research & Practice*, 17(1).
 2. Kelley, E. S., & Kinney, K. (2017). Word Learning and Story Comprehension from Digital Storybooks: Does Interaction Make a Difference? *Journal of Educational Computing Research*, 55(3), 410–428.
 3. Lee, S. H. (2017). Learning Vocabulary through E-Book Reading of Young Children with Various Reading Abilities. *Reading and Writing: An Interdisciplinary Journal*, 30(7), 1595–1616.
 4. *Smeets, D. J. H., & Bus, A. G. (2012). Interactive Electronic Storybooks for Kindergartners to Promote Vocabulary Growth. *Journal of Experimental Child Psychology*, 112(1), 36–55.
 5. Smeets, D. J. H., & Bus, A. G. (2015). The interactive animated e-book as a word learning device for kindergartners. *Applied Psycholinguistics*, 36, 899-920.

* As there are two studies in this paper they will be referred to as Smeets & Bus (2012a) and Smeets & Bus (2012b).

1.3.2 Critical Appraisal for quality and relevance

Gough's (2007) weight of evidence (WoE) framework was used to evaluate the six studies.

The framework enabled the reviewer to evaluate each study in three areas;

- WoE A: quality of the study's methodology
- WoE B: how relevant the methodology of the study was to the review question
- WoE C: how relevant the study was to answer the review question

The criteria chosen to evaluate WoE B and WoE C were selected by the reviewer to reflect the specificity to the review question.

The Gersten et al. (2005) criteria for evaluating evidence was adapted to the specific requirements of this review and used to rate the studies for WoE A as all were experimental or quasi-experimental in design. The Petticrew and Roberts (2003) evidence criteria was used to evaluate WoE B and for WoE C the reviewer created specific criteria. See Appendix 1C for WoE rating protocols and criteria. A final WoE D score was calculated by averaging the three area scores. Table 1.4 lists the scores for each WoE given to each study.

Table 1.4

The Reviewer's Weight of Evidence Judgements

Study	Quality of Methodology (WoE A)	Relevance of the Methodology (WoE B)	Relevance for the review question (WoE C)	Overall weighting (WoE D)
Broemmel, A. D., Moran, M. J., & Wooten, D. A. (2015)	2 (Medium)	2 (Medium)	3 (High)	2.33 (Medium)
Kelley, E. S., & Kinney, K. (2017)	3 (High)	3 (High)	3 (High)	3 (High)
Lee, S. H. (2017)	1 (Low)	2 (Medium)	1 (Low)	1.3 (Low)
Smeets, D. J. H., & Bus, A. G. (2012a)	1 (Low)	2 (Medium)	2 (Medium)	1.6 (Medium)
Smeets, D. J. H., & Bus, A. G. (2012b)	1 (Low)	2 (Medium)	2 (Medium)	1.6 (Medium)
Smeets, D. J. H & Bus, A. G. (2015)	3 (High)	3 (High)	3 (High)	3 (High)

Note. Scores of 2.5 and over are considered "high", 1.5 – 2.4 are considered "medium" and between 1 – 1.4 are considered "low".

1.3.3 Critical Review

1.3.3.1 Participants

A total of 334 young children participated in the studies in this review. Due to being recruited from pre-school and primary school settings the age range was limited, with the youngest child aged three years five months. It was not possible to establish the upper limits of the participants as Lee (2017) did not report the ages of their participants. Similarly, the gender ratio for all the participants could not be established as Kelley and Kinney (2017) did not report gender. Six participants were reported as having identified Special Educational Needs (SEN), two in the Broemmel et al. (2015) study and four in the Lee (2017) study.

Only four studies confirmed the first language of the participants (Broemmel et al., 2015; Smeets, & Bus, 2012a, 2012b; Smeets, & Bus, 2015) and two reported the ethnicity of the participants (Broemmel et al., 2015; Lee, 2017). In the early stages of language acquisition, children's first or home language plays a significant role in their learning of English and if English is their second language, acquisition may not follow an orderly or systematic pattern (Cummins, 1989). Therefore, the findings of three of the studies (Broemmel et al., 2015; Kelly, & Kinney, 2017; Lee, 2017) should be taken cautiously as this factor has not been taken into consideration in their findings.

Several studies reported the socioeconomic status (SES) of the children's families (Broemmel et al., 2015; Kelley, & Kinney, 2017; Smeets, & Bus, 2012a, 2012b). This is an important factor as research has shown children from low SES backgrounds typically have poorer emergent literacy skills when they start school compared to children from higher SES backgrounds (Hemphill, & Tivnan, 2008). However, none of the studies in this review evaluated this factor in their findings and therefore all results should be taken cautiously.

Interestingly given the nature of the intervention, only one study considered the computer literacy levels of their participants prior to implementing their intervention (Kelley, & Kinney, 2017). However, Lee (2017) provided 20 minutes of e-book instruction for all children to ensure that they had the necessary computer skills to access the intervention. The inconsistencies between the studies in reporting participant demographics makes it difficult to compare these factors in the results. However, the range of demographics reported by Broemmel et al. (2015) and Lee (2017) improves the generalisability of these study's findings. Table 1.5 shows the exact demographic details reported for each study.

Table 1.5

Demographics reported for by study

Demographics reported	Broemmel, Moran, & Wooten, (2015)	Kelley, & Kinney, (2017)	Lee, (2017)	Smeets, & Bus, (2012b)	Smeets, & Bus, (2012a)	Smeets, & Bus, (2015)
Sample Size	24	30	79	20	27	136
Age	3.11 - 5.9	3.5 - 5.5	Not Reported	4 - 5	4 - 5	4 - 6.5
Gender - Male	11	Not Reported	37	11	13	68
Gender - Female	13		42	9	14	68
Ethnicity of participants	8 African-American 2 Bi-racial 8 Caucasian 2 Chinese	Collected but not reported	2 African-American 2 Asian 72 Caucasian 2 Middle Easterner 1 Latino	Not Reported	Not Reported	Not Reported
SES - High	0	21	Not Reported	0	0	Not Reported
SES - Middle	10	Collected		20	27	
SES - Low	14	but not reported		0	0	

Demographics reported	Broemmel, Moran, & Wooten, (2015)	Kelley, & Kinney, (2017)	Lee, (2017)	Smeets, & Bus, (2012b)	Smeets, & Bus, (2012a)	Smeets, & Bus, (2015)
SEN	1 speech impairment 1 language comprehension impairment	Not Reported	3 Speech impairment 1 mild intellectual disabilities	None	None	None
Maternal education	Not Reported	professional degree (n = 10) bachelor's degree (n = 4) college (n = 4)	Not Reported	Not Reported	Not Reported	Not Reported
pre-study computer literacy levels	Not Reported	16 children had digital devices at home & of these 6 used them daily.	Not Reported	Not Reported	Not Reported	No children had issues using equipment
Home Languages (L1)	21 English 1 Spanish 2 Chinese	Collected but not reported	Not Reported	Dutch	Dutch	Dutch

1.3.3.2 Research Design

Three of the studies used a randomised control design (Broemmel et al., 2015; Kelley, & Kinney, 2017; Smeets, & Bus, 2015). All these studies were rated high for WoE B as using a control group enables the impact of the intervention to be effectively evaluated against other factors (Petticrew, & Roberts, 2003). The other three studies utilised a quasi-experimental pre and post-test, within participants design (Lee, 2017; Smeets, & Bus, 2012a, 2012b), counterbalancing the order of the interventions to reduce the impact of order effect (Lewis-Beck, Bryman, & Futing Liao, 2012). All the studies in this review had high ecological validity as they took place in standard preschool and primary school settings which mirror the English education system.

1.3.3.3 Intervention

Five of the six studies compared e-books to printed versions of the same story. The study by Broemmel et al. (2015) was the only one to use printed books that also had interactive features such as tabs to pull and flaps to lift to reveal additional information about the story. This helped to mitigate the impact of interactive features on the findings and improved the validity of this study. This study also described the interactive and specific e-book features in detail which enables the findings to be generalised to other settings contributing to a High WoE C rating (See appendix 1C for WoE C rating criteria and scores).

In the Kelley and Kinney (2017) study, one story was used for all conditions and accessed via an iPad. The e-book interactive features of the books were described in detail and in the control condition the interactive features were turned off. This gave this study greater validity as it enabled the impact of this specific feature to be evaluated contributing to its high WoE C rating.

The Lee (2017) study used commercial e-book readers for their intervention. Exact details of e-books features such as animation and sound effects were not reported except for one book

which did not have any audio narration. The lack of information regarding these features and the absence of narration in one of the e-books made it difficult to compare the results of this study with others in this review. This reduced the generalizability of the findings and the ability of the study to answer the review question.

Smeets and Bus (2012a, 2012b) used computers to deliver their intervention. While detailed information regarding the stories and the e-book features were provided, the e-book versions of the stories were created by the authors and it was not possible to establish how closely the intervention stories replicate the e-books used in the other studies. This and the difficulty in generalising these findings reduced the studies ability to answer the review question resulting in a lower WoE C rating.

The Smeets and Bus (2015) study used commercially available e-book stories and provided very detailed information regarding the features available in the e-books and how these features and the story illustrations varied across the intervention conditions resulting in a high WoE C rating.

1.3.3.4 Measures

Five of the studies pre-tested the participants using the Peabody Picture Vocabulary Test (PPVT-III) (Campbell, & Dommestrup, 2010), with Smeets and Bus (2012a, 2012b) and Smeets and Bus (2015) administering the Dutch version (PPVT-III-NL). Although the study's authors did not report the appropriateness of this assessment, the reviewer has established that is is an age appropriate measure with a test-retest reliability coefficient of .91 - .94 (Campbell,& Dommestrup, 2010). Lee (2017) used the Test of Silent Reading Efficiency and Comprehension (TOSREC) (Dickens, Meisinger, & Tarar, 2015) to pre-screen and sub divide their participants on reading ability within each group.

The Smeets and Bus (2015) study used the PPVT-III-NL and Taaltest voor Kinderen (TvK: Language Test for Children) (Van Bon, & Hoekstra, 1982) Expressive vocabulary task as pre and post-test measures and were the only study to do a follow up one week post intervention measure. The TvK is a standardise language assessment battery suitable for children from the age of 4 onwards (Bokhorst, & Joeris, 2011). Using a standardised assessment improves the validity and reliability of this study's findings which is reflected in its high WoE C and overall WoE D rating.

Broemmel et al. (2015) and Kelley and Kinney (2017) were the only studies to assess children's motivation and engagement in the intervention and report this in detail.

As the focus of this review was vocabulary acquisition, only assessments measuring this have been evaluated. The study by Lee (2017) used a multiple choice vocabulary test, however as the details of the test methodology, validity, reliability and results were not reported it was rated low for WoE C.

Five studies utilised researcher created measures for evaluating expressive vocabulary acquisition. Three studies used a picture cued story re-tell measure (Broemmel et al., 2015; Kelley, & Kinney, 2017; Smeets, & Bus, 2015) and two, Smeets and Bus (2012a, 2012b), used a picture cued sentence completion task. Only Broemmel et al. (2015), Kelley and Kinney (2017) and Smeets and Bus (2015) provided a detailed methodology for administering and scoring their assessment measure and while they reported that they had assessed interrater reliability only Kelley and Kinney (2017) reported the details. This gives greater validity to the results of this study.

To assess receptive vocabulary, Smeets and Bus (2015) used the PPVT-III NL and Broemmel et al. (2015), Kelley and Kinney (2017) and Smeets and Bus (2012a, 2012b) used their own

researcher created pre and post-test measure using a PPVT format. The total number of target words tested varying greatly between the studies (Broemmel et al., (2015) = 8; Smeets and Bus (2012a, 2012b) = 40) which could impact on the results with the number of words being a factor in participant's learning independent of other factors. Broemmel et al. (2015) tested participants weekly over the 3 weeks of their studies potentially limiting the reliability of their results due to a practice effect confounding their results.

While researcher created assessment methods are acceptable measures to use, the lack of any reported validity or reliability measures such as Cronbach's Alpha makes it difficult to effectively evaluate the results of these studies (Barker, Pistrang, & Elliott, 2016). Kelley and Kinney (2017) and Smeets and Bus (2015) were the only studies to report these measures, contributing to their final high WoE D rating.

1.3.3.5 Findings

To enable the reviewer to compare pre and post outcome measures across all studies, effect sizes were either calculated from reported data or converted from reported effect sizes to Cohen's *d* (Morris, 2008) with Cohen's (2013) descriptors used. Table 1.6 details the effect sizes for the study outcomes relevant to the review question and their descriptors.

The Broemmel et al, (2015) study was the only one to not find any significant effect on vocabulary acquisition for e-books compared to traditional printed books. This could be due to the control group reading with adult support or a range of methodological issues such as repeated measurements and practice effect across all groups. The study's medium WoE A and B ratings reflect these issues. Due to the impact methodological issues have on the overall reliability of findings, caution should be exercised in interpreting these results.

The remaining five studies all found that e-books had a positive impact on either receptive or expressive vocabulary gains or both. The study by Kelly and Kinney (2017) found that the interactive features such as hotspots and animations in e-books produced medium effect size gains in expressive vocabulary but no gains in receptive vocabulary ($d = 0.01$). Conversely, the study by Lee (2017) found a medium effect size for gains in receptive vocabulary but not expressive vocabulary when the e-book was supplemented with explicit instructions from teachers. However, given the low WoE D rating for this study, these results should be viewed with caution and this finding does not indicate that e-books are effective but rather that additional instruction improves vocabulary acquisition independent of e-books.

Both studies by Smeets and Bus (2012a, 2012b) found that interactive features such as questions and hotspots improved both receptive and expressive vocabulary. The studies had very large effect sizes for their intervention groups compared to their control groups. Interestingly, Smeets and Bus (2012a) found that both types of interactive feature were effective compared to the control group but the study by Smeets and Bus (2012b) found that answering questions promoted greater learning than interacting with hotspots for both receptive vocabulary ($d = 2.48$ vs $d = 0.41$ respectively) and expressive vocabulary ($d = 3.63$ vs $d = 1.54$ respectively). This suggest that the interactive features in e-books, in particular questions relating to specific vocabulary within the story, supports children's vocabulary acquisition. However, both these studies were scored low for their WoE A rating suggesting a lack of methodological rigour that impacts of the reliability of the findings. This, combined with a medium WoE D rating, would indicated that caution should be exercised when interpreting these results as they would be difficult to generalise to other cohorts of children, school contexts or e-books.

The Smeets and Bus (2015) study also found that interactive features produced a very large effect on expressive vocabulary gains compare to the control group and static e-books and a

large effect size gain compared to video e-books. There were no effective gains in receptive vocabulary across any condition. Both this study and the Kelly and Kinney (2017) study were rated high (WoE D = 3) adding greater validity to their findings and enabling these to be generalised across to school based populations. Their findings would suggest that the interactive features of e-books, in particular hotspots and animations have an effect on expressive vocabulary gains in typically developing children. However, it should be noted that the results are applicable to the specific e-books used in these studies and despite the high WoE D rating caution should be applied to generalising the findings to other e-books as the specifics of the interactive features have not be evaluated.

Table 1.6*Effect Sizes for Study Outcomes Relevant to the Review Question and Their Descriptors*

Study	Sample size	Case/Group	Outcomes relevant to the Review Question	Effect Size (ES) type	Effect Size	Standardised ES (Cohen's <i>d</i>)	ES Descriptor	Overall Weighting (WoE D)
Broemmel, Moran & Wooten, (2015)	24		None - e-books did not have a significant effect on vocabulary	-	-	-	-	2.33 (Medium)
Kelley & Kinney, (2017)	30	Interactive e-book vs control	Gains in definitional work knowledge (expressive vocabulary)	Cohen's <i>d</i>	0.44	-	Medium	3 (High)
		Interactive e-book vs control	Gains in de-contextual word knowledge (expressive vocabulary)	Cohen's <i>d</i>	0.38	-	Medium	
Lee, (2017)	79	E-book with word teaching	Receptive Vocabulary Gains	Cohen's <i>d</i>	0.56	-	Medium	1.3 (Low)
		E-book without word teaching	Receptive Vocabulary Gains	Cohen's <i>d</i>	0.14	-	Small	
Smeets & Bus (2012a)	20	E-books (pooled) vs Control Questions during vs after	Target word knowledge gains (Expressive & Receptive Vocabulary)	Partial eta squared	$\eta_p^2 = 0.66$	2.78	Very Large	1.6 (Medium)
			Target receptive vocabulary gains	Cohen's <i>d</i>	1.49	-	Very Large	
			Target expressive vocabulary gains	Cohen's <i>d</i>	3.04	-	Very Large	
		Hotspots vs control	Target receptive vocabulary gains	Cohen's <i>d</i>	1.19	-	Very Large	

Study	Sample size	Case/Group	Outcomes relevant to the Review Question	Effect Size (ES) type	Effect Size	Standardised ES (Cohen's <i>d</i>)	ES Descriptor	Overall Weighting (WoE D)
			Target expressive vocabulary gains	Cohen's <i>d</i>	2.42	-	Very Large	
Smeets & Bus (2012b)	27	E-books (pooled) vs Control Questions vs control	Target word knowledge gains (Expressive & Receptive Vocabulary)	Partial eta squared	$\eta_p^2 = 0.46$	1.84	Very Large	1.6 (Medium)
			Target receptive vocabulary gains	Cohen's <i>d</i>	2.48	-	Very Large	
		Target expressive vocabulary gains	Cohen's <i>d</i>	3.63	-	Very Large		
		Hotspots vs control	Target receptive vocabulary gains	Cohen's <i>d</i>	0.41	-	Medium	
			Target expressive vocabulary gains	Cohen's <i>d</i>	1.54	-	Very Large	
Smeets & Bus, (2015)	67	Interactive e-book vs control	Target vocabulary (Expressive) gains	Cohen's <i>d</i>	5.81	-	V Large	3 (High)
		Interactive e-book vs static e-book		Cohen's <i>d</i>	1.50	-	V Large	
		Interactive e-book vs video e-book		Cohen's <i>d</i>	0.82	-	Large	

Notes. 1) N represents the number of participants included in the final data analysis for each study. 2) 0.2 = small; 0.5 = medium; 0.8 = large (Cohen, 2013). 3) Effect sizes were calculated using the method recommended by Morris (2008) for Cohen's *d*.

1.4 Summary and Conclusions

This review aimed to evaluate the effectiveness of e-books in promoting vocabulary acquisition in emergent readers. While the majority of the studies in the review found medium to large effect sizes on both receptive and/or expressive vocabulary acquisition there are a number of factors to consider.

The studies that found the largest effect sizes for vocabulary acquisition used e-books with interactive features that provided additional explanations of the meaning of words appearing in the text. Research has shown that young children benefit more from shared reading with adults than independent reading and these e-book features replicated these type of interactions (Bodle, 2019; Dickinson, & Porche, 2017). The one study in this review in which adults in the control group engaged in shared reading of printed books with the children (Broemmel et al., 2015) found no difference in vocabulary acquisition between the groups. This implies that while the interactive features of e-books that specifically encourage vocabulary acquisition are beneficial during independent reading activities, they do not provide any additional benefits compared to shared reading activities with adults. The study by Lee (2017) would appear to support these findings with results showing explicit instructions from teachers in conjunction with reading e-books impacting on vocabulary acquisition. However, while the medium WoE D rating for the Broemmel et al. (2015) study suggest that the results can be considered more confidently than those of the Lee (2017) study which had a low Woe D rating, the influence both these studies have on supporting the evidence that e-books are effective at promoting vocabulary acquisition is reduced. It is therefore concluded that further research is required to evaluate if e-books are as effective as shared reading when used independently by children.

Many of the e-books selected for these studies were specifically chosen or created to have the optimum features for engagement and learning. This is an important factor to consider as

many e-books are not specifically created for educational purposes and therefore have a wide range and quality of features (Bus et al., 2015; de Jong, & Bus, 2003). As the study by Kelley and Kinney (2017) only found a medium effect when comparing the same e-book with and without interactive features, it would suggest that the quality of the interactive features can impact on learning. Interestingly, both the Kelley and Kinney (2017) and The Smeets and Bus (2015) study found that e-books with interactive features produced an effect on expressive and not receptive vocabulary. Given the high WoE D rating of both these studies, these findings carry more weight than others in this review and can be considered with greater confidence than other studies with lower ratings. However, a limitation of all the studies in this review was the lack of specificity regarding which aspects of each interactive feature had contributed to the findings. For example, both repetition of words and providing an explanation of a word have been shown to promote vocabulary acquisition independently of each other (Coyne, McCoach, Loftus, Zipoli Jr, & Kapp, 2009). In addition, research by Sari et al. (2019) found that while story comprehension was improved by visual enhancements that aligned the reader's attention to the text, other features such as music and sounds had a negative impact on comprehension and detracted from the benefits gained by the visual enhancements. The only study which attempted to address this issue was the Broemmel et al. (2015), however the medium WoE D rating for this study reduces its influence on the conclusions of this review. Further research into the impact of both the quality and specific aspects of interactive features that might promote vocabulary acquisition is recommended.

An additional limiting factor for the studies reviewed was the short duration of the intervention and the testing for specific target vocabulary that was specifically chosen from high frequency words appearing in the intervention books. The lack of a general assessment of vocabulary acquisition at either immediate post-test or longer term follow up restricts the generalisability of the findings. This would suggest that further studies looking at the long term benefits of e-books for vocabulary acquisition are required.

While several of the studies reported the SES and the first language of their participants, these factors were not evaluated in their findings. Other studies have found that children from lower SES backgrounds have greater gains in receptive vocabulary than children from middle SES backgrounds when reading e-books with interactive features (Korat, & Shamir, 2008; Korat, & Blau, 2010; Shamir, & Korat, 2007; Shamir, Korat, & Barbi, 2008). As these studies were for Hebrew speaking, Israeli children the results are difficult to generalise to UK populations. Further research into the effectiveness of e-books on vocabulary acquisition across SES groups and for EAL children in the UK is recommended.

While several studies in this review with high WoE D ratings found that e-books were effective in promoting vocabulary acquisition in young children, due to the range of limiting factors discussed it is concluded that there is insufficient evidence for EP's to recommend e-books specifically for the purposes of promoting vocabulary acquisition. It is recommended that due to a lack of empirical evidence e-books should continue to be used in shared reading activities between adults and young children rather than independent reading activities. They provide an additional way of engaging young children in reading and can increase a child's enjoyment and engagement in reading which, in itself, can promote the development of emergent literacy skills in young children .

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1.6 Appendices

Appendix 1A: Excluded Studies with Rationale

Table 1.7

Studies excluded from this Literature Review with rationale

Studies excluded at abstract screening	
Rationale / Exclusion Criteria	Study
1. The study is not an experimental group based design with primary empirical pre and post measure data	Ciampa, K. (2012). ICANREAD: The effects of an online reading program on grade 1 students' engagement and comprehension strategy use. <i>Journal of Research on Technology in Education</i> , 45(1), 27–59.
	Eng, Cassandra M, Tomasic, Anthony S & Thiessen, Erik D. (2019). Contingent responsivity in E-books modeled from quality adult-child interactions: Effects on children's learning and attention. <i>Developmental Psychology</i> , No Pagination Specified.
	Hsiao, K.-L., & Chen, C.-C. (2015). How do we inspire children to learn with e-readers? <i>LIBRARY HI TECH</i> , 33(4), 584–596.
	Morgan, H. (2013). Multimodal Children's E-Books Help Young Learners in Reading. <i>Early Childhood Education Journal</i> , 41(6), 477–483.
	Rhodehouse, S. B. (2013, January 1). <i>Teaching Vocabulary to Preschoolers with Disabilities Using Adult-Child Shared Bookreading: A Comparison of Traditional and Electronic Books</i> . ProQuest LLC. ProQuest LLC.
	Richter, A., & Courage, M. L. (2017). Comparing electronic and paper storybooks for preschoolers: Attention, engagement, and recall. <i>Journal of Applied Developmental Psychology</i> , 48, 92–102.
	Sauermilch, W., & Pearson. (2018). The Effects of Multimedia E-Book Use on Vocabulary Acquisition for Children with Language Impairments. EBP Briefs. Volume 13, Issue 2. <i>EBP Briefs (Evidence-Based Practice Briefs)</i> .
	Schneider, J. J., Kozdras, D., Wolkenhauer, N., & Arias, L. (2014). Environmental E-Books and Green Goals Changing Places, Flipping Spaces, and Real-izing the Curriculum. <i>Journal of adolescent & adult literacy</i> , 57(7), 549–564.

Studies excluded at abstract screening:

Rationale / Exclusion Criteria	Study
1. The study is not an experimental group based design with primary empirical pre and post measure data	Shamir, A., Korat, O., & Barbi, N. (2008). The Effects of CD-ROM Storybook Reading on Low SES Kindergarteners' Emergent Literacy as a Function of Learning Context. <i>Computers & Education</i> , 51(1), 354–367.
	Shamir, A., Korat, O., & Fella, R. (2012). Promoting Vocabulary, Phonological Awareness and Concept about Print among Children at Risk for Learning Disability: Can E-Books Help? <i>Reading and Writing: An Interdisciplinary Journal</i> , 25(1), 45–69.
	Tosun, Nilgun. (2014). A study on reading printed books or e-books: Reasons for student-teachers preferences. <i>TOJET: The Turkish Online Journal of Educational Technology</i> , 13(1), 21-28.
	Turel, Y. K., & Sanal, S. O. (2018). The effects of an ARCS based e-book on student's achievement, motivation and anxiety. <i>COMPUTERS & EDUCATION</i> , 127, 130–140.
	Van Dijken, M. J., Bus, A. G., & de Jong, M. T. (2011). Open access to living books on the internet: A new chance to bridge the linguistic gap for at-risk preschoolers? <i>European Journal of Special Needs Education</i> , 26(3), 299–310. 3
3. The study did not evaluate pre & post measures of vocabulary	Klop, D., Marais, L., Msindwana, A., & de Wet, F. (2018). Learning new words from an interactive electronic storybook intervention. <i>South African Journal of Communication Disorders</i> , 65(1).
	Shamir, A., & Schlafer, I. (2011). E-books effectiveness in promoting phonological awareness and concept about print: A comparison between children at risk for learning disabilities and typically developing kindergarteners. <i>Computers and Education</i> , 57(3), 1989–1997.
4. The study did not involve typically developing children between 4 – 7 years old.	Korat, O., & Blau, H. (2010). Repeated Reading of CD-ROM Storybook as a Support for Emergent Literacy: A Developmental Perspective in Two SES Groups. <i>Journal of Educational Computing Research</i> , 43(4), 445–466.
	Korat, O., & Shamir, A. (2007). Electronic Books versus Adult Readers: Effects on Children's Emergent Literacy as a Function of Social Class. <i>Journal of Computer Assisted Learning</i> , 23(3), 248–259.

Studies excluded at abstract screening:

Rationale / Exclusion Criteria	Study
4. The study did not involve typically developing children between 4 – 7 years old.	<p>Segal-Drori, O., Korat, O., Shamir, A., & Klein, P. S. (2010). Reading electronic and printed books with and without adult instruction: Effects on emergent reading. <i>Reading and Writing</i>, 23(8), 913–930.</p> <p>Shamir, A. (2009). Processes and outcomes of joint activity with e-books for promoting kindergarteners' emergent literacy Processus et Résultats d'une activité associée aux livres en ligne pour promouvoir les débuts de l'alphabétisation chez les enfants de la maternelle . <i>Educational Media International</i>, 46(1), 81–96.</p>
3.	<p>Shamir, A., & Korat, O. (2007). Developing an educational E-book for fostering kindergarten children's emergent literacy. <i>Computers in the Schools</i>, 24(1–2), 125–143.</p> <p>Shamir, A., & Korat, O. (2015). Educational Electronic Books for Supporting Emergent Literacy of Kindergarteners At-Risk for Reading Difficulties--What Do We Know so Far? <i>Computers in the Schools</i>, 32(2), 105–121.</p> <p>Shamir, A., Korat, O., & Shlafer, I. (2011). The Effect of Activity with E-Book on Vocabulary and Story Comprehension: A Comparison between Kindergarteners at Risk of Learning Disabilities and Typically Developing Kindergarteners. <i>European Journal of Special Needs Education</i>, 26(3), 311–322.</p> <p>Smeets, D. J. H., van Dijken, M. J., & Bus, A. G. (2014). Using electronic storybooks to support word learning in children with severe language impairments. <i>Journal of Learning Disabilities</i>, 47(5), 435–449.</p> <p>Verhallen, M. J. A. J., & Bus, A. G. (2010). Low-Income Immigrant Pupils Learning Vocabulary through Digital Picture Storybooks. <i>Journal of Educational Psychology</i>, 102(1), 54–61.</p>
5. The intervention has not used an electronic book in some format (tablet or mobile device or on a PC) in a school or educational setting.	<p>Elimelech, A., & Aram, D. (2019). A Digital Early Spelling Game: The Role of Auditory and Visual Support. <i>AERA OPEN</i>, 5(2).</p> <p>Willoughby, D., Evans, M. A., & Nowak, S. (2015). Do ABC eBooks boost engagement and learning in preschoolers? An experimental study comparing eBooks with paper ABC and storybook controls. <i>Computers and Education</i>, 82, 107–117.</p>

Studies excluded at abstract screening:

Rationale / Exclusion Criteria	Study
6. The study was not conducted in a language that has a high genetic proximity to English	Korat, O., Levin, I., Atishkin, S., & Turgeman, M. (2014). E-Book as Facilitator of Vocabulary Acquisition: Support of Adults, Dynamic Dictionary and Static Dictionary. <i>Reading and Writing: An Interdisciplinary Journal</i> , 27(4), 613–629.
	Korat, O., Levin, I., Ben-Shabt, A., Shneor, D., & Bokovza, L. (2014). Dynamic versus Static Dictionary with and without Printed Focal Words in e-Book Reading as Facilitator for Word Learning. <i>Reading Research Quarterly</i> , 49(4), 371–386.
	Korat, O., Shamir, A., & Arbiv, L. (2011). E-books as support for emergent writing with and without adult assistance. <i>Education and Information Technologies</i> , 16(3), 301–318.

Studies Excluded at full text screening:

Rationale / Exclusion Criteria	Study
4. The study did not involve typically developing children between 4 – 7 years old.	Connor, C. M., Day, S. L., Zargar, E., Wood, T. S., Taylor, K. S., Jones, M. R., & Hwang, J. K. (2019). Building word knowledge, learning strategies, and metacognition with the Word-Knowledge e-Book. <i>Computers and Education</i> , 128, 284–311.
	Lee, S. (2019). Learning vocabulary from e-book reading and recorded word explanation for low-income elementary students with and without reading difficulties. <i>Reading and Writing</i> , 1-27.
	Zipke, M. (2017). Pre-schoolers explore interactive storybook apps: The effect on word recognition and story comprehension. <i>Education and Information Technologies</i> , 22(4), 1695–1712.
6. The study was not conducted in a language that has a high genetic proximity to English	Ihmeideh, F. M. (2014). The effect of electronic books on enhancing emergent literacy skills of pre-school children. <i>Computers and Education</i> , 79, 40–48.
	Korat, O. (2010). Reading Electronic Books as a Support for Vocabulary, Story Comprehension and Word Reading in Kindergarten and First Grade. <i>Computers & Education</i> , 55(1), 24–31.

Studies Excluded at full text screening:

Rationale / Exclusion Criteria	Study
6. The study was not conducted in a language that has a high genetic proximity to English	<p data-bbox="624 324 1385 465">Korat, O., & Segal-Drori, O. (2016). E-Book and Printed Book Reading in Different Contexts as Emergent Literacy Facilitator. <i>Early Education and Development</i>, 27(4), 532–550.</p> <p data-bbox="624 495 1385 636">Korat, O., & Shamir, A. (2008). The educational electronic book as a tool for supporting children’s emergent literacy in low versus middle SES groups. <i>Computers and Education</i>, 50(1), 110–124.</p> <p data-bbox="624 665 1385 831">Korat, O., & Shamir, A. (2012). Direct and Indirect Teaching: Using E-Books for Supporting Vocabulary, Word Reading, and Story Comprehension for Young Children. <i>Journal of Educational Computing Research</i>, 46(2), 135–152.</p> <p data-bbox="624 860 1385 1001">Korat, O., Kozlov-Peretz, O., & Segal-Drori, O. (2017). Repeated E-Book Reading and Its Contribution to Learning New Words among Kindergartners. <i>Journal of Education and Training Studies</i>, 5(7), 60–72.</p> <p data-bbox="624 1030 1385 1171">Korat, O., Segal-Drori, O., & Klien, P. (2009). Electronic and Printed Books with and without Adult Support as Sustaining Emergent Literacy. <i>Journal of Educational Computing Research</i>, 41(4), 453–475.</p> <p data-bbox="624 1200 1385 1341">Kozminsky, E., & Asher-Sadon, R. (2013). Media Type Influences Pre-schooler’s Literacy Development: E-Book versus Printed Book Reading. <i>Interdisciplinary Journal of E-Learning and Learning Objects</i>, 9, 233–247.</p> <p data-bbox="624 1370 1385 1529">Sari, Burcu, Basal, Handan Asude, Takacs, Zsofia K & Bus, Adriana G. (2019). A randomized controlled trial to test efficacy of digital enhancements of storybooks in support of narrative comprehension and word learning. <i>Journal of Experimental Child Psychology</i>, 179, 212-226.</p>

Appendix 1B: Summary of Studies Included in the Review

Table 1.8

Summary of the Included Studies Used In This Review (Mapping the Field)

Author	Study design & Aims	Methodology	Intervention (Type of E Book Used/special characteristics)	Sample size, Age & Gender	Measures used	Outcomes Reported
Broemmel, Moran, & Wooten, (2015)	A quasi experimental stratified convenience sample balanced for Gender	2 intervention groups & 2 control group. Day 1. Books were read & focus children completed retell task with the researcher. Days 2 - 4: focus children read 3 times over this period.	The e-books had animation, narration, sound effects and music to dramatize the story.	Size: 24 ULS Group = 10, Head Start group (HS) = 14 Age: ULS Group = 3.11 - 5.9 , HS = 4.5 - 5.8 Gender: M = 11, F = 13	Pre-test: Peabody Picture Vocabulary Test (PPVT-IV) Curriculum-based vocabulary test created by researchers and based on the PPVT.	Vocabulary growth was significant for both groups with pre-test vocabulary having a significant effect. Both conditions improved in ability from pretelling to retelling of the stories
	Aims: evaluate the impact of e-books on vocabulary and understanding.	Day 5: vocabulary measure and retelling task completed with focus children.	Interactive features = hotspots, animated characters, questions relating to the story,	Location & Language: USA & English	Audio taped weekly pretelling task (beginning of week) and a retelling task (end of week)	

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		Delivered by - researchers were in each group for the whole study and collected data at the beginning of each week for three weeks.		Other: Some children were EAL	Teacher focus group and researcher field notes	
				SES: Middle SES for the ULS group, low SES for the HS group	Fidelity reported: yes, numbers adjusted for school absences & missing data	
					Follow up Measures: None	
Kelley, & Kinney, (2017)	RCT Aims: Do interactive features of e-book impact on language learning?	Two sites each with two conditions (Interactive & Non interactive) Both groups watched the story on the iPad three times in total each on a different day.	Commercially available digital book accessed on an iPad. Interactive features = hotspots, animated characters, questions relating to the story,	Size: 30 (Intervention Group = 15) Age: 3 yrs, 5 months - 5 yrs, 5 mths Mean: 55 mths Gender: Not reported	Pre-test: Peabody Picture Vocabulary Test (PPVT-IV)	No significant difference between groups or ages No significant difference between groups or ages

Author	Study design & Aims	Methodology	Intervention (Type of E Book Used/special characteristics)	Sample size, Age & Gender	Measures used	Outcomes Reported
		<p>Delivered by - researchers were in the room and only encouraged engagement</p>		<p>Location & Language: Not reported (Authors based in USA)</p>	<p>During intervention - an engagement and motivation scale adapted from the mediated learning observation (Peña, Reséndiz, & Gillam, 2007)</p>	<p>All children scored highly on motivation and on engagement</p>
				<p>SES: High to low, depending on group</p>	<p>Post-test -researcher created work knowledge tests for;</p>	<p>There was no significant effect of intervention.</p>
					<p>definitional expressive vocabulary</p>	
					<p>decontextualize expressive vocabulary & Receptive Vocabulary</p>	
					<p>Post-test: Story re-tell task, scored using Computerised Language Analysis (CLAN; MacWhinney, 1995)</p>	<p>No significant difference between groups</p>
					<p>Fidelity reported: Yes - 7 children were excluded for measures they did not complete</p>	
					<p>Follow up Measures: None</p>	

Author	Study design & Aims	Methodology	Intervention (Type of E Book Used/special characteristics)	Sample size, Age & Gender	Measures used	Outcomes Reported
Lee, (2017)	quasi-experimental within groups with pre-test & post-test measures	Teachers from 4 1st grade classes had e-book & assessment training. Day 1: whole class completed pre-tests. Day 2: whole class taught to use NOOK® device.	Four Barnes & Noble NOOK® e-readers were used. Four e-books, three with audio narration were used.	Size: 79	Pre-test: TOSREC (Wagner) reading efficiency and comprehension test was used to grade children as skilled, average or poor readers.	Significant gains in word meaning scores across the three conditions from pre-test to post-test.
	Aims: evaluate the effect of e-books on incidental vocabulary learning	Day 3 & 4: E-book read and a group post-test vocabulary test completed.	2 conditions: 1 - target words explained prior to reading book. 2 - no target words explained	Age: first grade (6 - 7 yrs.) Mean: not reported Gender: M = 37, F = 42	Pre-test: multiple choice vocabulary test. Children were asked to select the meaning of the target word (n=30) from four possible choices.	Advanced readers had gains in word meaning scores between the e-book with explanation and the control condition.
	with and without teacher explanations for novel words.	The explained condition was counterbalanced between groups on day 3 & 4		Other: 4 students had Individual Education Plans	Post-test: multiple choice vocabulary test.	Average readers had significant gains in word meaning scores across the three conditions.

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		Delivered by - class teachers administered the assessments and provided instruction		Location & Language: USA & English	Fidelity reported: No	Poor readers had gains in word meaning scores between the e-book with explanation and the control condition.
Smeets, & Bus, (2012a)	Quasi-experimental pre-test & post-test, within-participant Aims: 1. Do e-books with extra textual vocabulary instruction improve learning.	2 primary schools sites, 1 group each with 3 within group conditions. 1: read only control, 2: story interrupted by questions. 3: Questions after the story. Stories were read twice in every condition.	Online video versions of the storybooks were used without accompanying text but with narration. In questioning conditions, children clicked on picture to answer oral vocabulary question.	SES: Not reported Size: 20 Age: 4 yrs. - 5 yrs.	Follow up Measures: None Pre Test: PPVT-III_NL Pre & post-test: Receptive vocabulary - knowledge of target words test using 40 target words identified by the researchers.	Expressive and Receptive vocabulary increases were significant for every condition. Expressive & Receptive Vocabulary gains were significantly higher for instructed words.

Author	Study design & Aims	Methodology	Intervention (Type of E Book Used/special characteristics)	Sample size, Age & Gender	Measures used	Outcomes Reported
	2. Does interrupting reading impact on learning.	Order of stories was counterbalanced over a 2.5 week period. Condition 2 & 3 additional conditions: 1. Instructed = target words in the texts & questions 2. Non-instructed words = target words in the texts but not the questions. Delivered by - researchers were in the room and only encouraged engagement	In the interrupted condition, the question interrupted the narration. Incorrect answers were followed with supportive feedback until the correct answer was provided.	Mean: 54.50 mths Gender: M = 11, F = 9 Location & Language: Holland & Dutch SES: Middle	Pre & post-test: a sentence completion task was used to evaluate expressive vocabulary. Intraclass correlation = 0.996 Fidelity reported: No Follow up Measures: None	Effects of level of word knowledge and condition (questions during or after) were not significant. For receptive vocabulary present at pre-test, 45% were learned expressively in the instructed condition at post-test. 33% of instructed novel words were learned as receptive & expressive vocabulary. 13% of non-instructed novel words were learned as receptive & expressive vocabulary

Author	Study design & Aims	Methodology	Intervention (Type of E Book Used/special characteristics)	Sample size, Age & Gender	Measures used	Outcomes Reported
Smeets, & Bus, (2012b)	Quasi-experimental pre-test & post-test, within-participant	3 primary schools sites, 1 group each with 3 within group conditions. 1: read only control.	Online video versions of the storybooks were used without accompanying text but with narration.	Size: 27	Pre Test: PPVT-III-NL	No effect of condition on receptive or expressive vocabulary. Interrupting reading did not affect word learning.
	Aims: 1. Are experiment 1's findings replicated?	2: story was interrupted for questions. 3: story was interrupted for hotspots. Stories were read twice in every condition.	In questioning conditions, children clicked on picture to answer oral vocabulary question.	Age: 4 yrs. - 5 yrs.	Pre & post-test - Receptive vocabulary - knowledge of target words test using 40 target words identified by the researchers.	Word knowledge gains were significantly higher in instructed conditions than non-instructed.
	2. Are hotspots more interfering than questions?	Order of stories was counterbalanced over a 2.5 week period.	In the hotspot condition, the children clicked on a hotspot to produce an oral explanation of a target word.	Mean: 57.56 mths	Pre & post-test - a sentence completion task was used to evaluate expressive vocabulary. Intraclass correlation = 0.996	Post-hoc analysis found questions were as effective as reading alone on receptive vocabulary learning

Author	Study design & Aims	Methodology	Intervention (Type of E Book Used/special characteristics)	Sample size, Age & Gender	Measures used	Outcomes Reported
		<p>Condition 2 & 3 additional conditions: 1. Instructed = target words in the texts with explanations 2. Non-instructed words = target words in the texts only.</p> <p>None of the children had been in experiment 1.</p> <p>Delivered by - researchers were in the room and only encouraged engagement</p>	<p>Incorrect answers were followed with supportive feedback until the correct answer was provided.</p>	<p>Gender: M = 13, F = 14</p> <p>Location & Language: Holland & Dutch</p> <p>SES: Middle</p>	<p>Fidelity reported: No</p> <p>Follow up Measures: None</p>	<p>For expressive vocabulary, there was a significant main effect of word type (instructed vs non instructed)</p> <p>No significant difference for either receptive or expressive vocabulary alone for either condition.</p> <p>For receptive vocabulary present at pre-test, the question condition had higher gains for expressive vocabulary learning compared to hotspots.</p>

Author	Study design & Aims	Methodology	Intervention (Type of E Book Used/special characteristics)	Sample size, Age & Gender	Measures used	Outcomes Reported
Smeets, & Bus, (2015)	RCT (participants stratified for school and gender)	Three intervention groups and 1 control group. Condition 1. Static e-book with oral reading of text.	Static e-books pictures with a computer generated narration, no text was present.	Size: 136	Pre & Post Test: PPVT-III_NL	The PPVT was related with target vocabulary scores. Post-test target vocabulary & comprehension scores were strongly correlated.
	Aims: 1. Do e-books stimulate word learning & story comprehension?	2. Animated e-book with oral reading of text.	Animated e-books replicating static e-books with animated effects, sound effects and music added.	Age: 4 yrs. - 6.5 yrs.	Pre & Post Test: TvK expressive vocabulary task (Language test for Children)	For receptive vocabulary present at pre-test, 45% were learned expressively in the instructed condition at post-test.
	2. Do multimedia and interactive vocabulary instruction increase learning and comprehension?	3. Interactive e-book with hotspots and vocabulary instruction.	Interactive animated e-book with hotspots automatically highlighted target details and narrator repeated the relevant words from the story.	Mean: 63.47 mths	Pre & Post Test: Target vocabulary test (sentence completion task)	Word learning gains for animated e-books were significantly higher than static e-book group (6% higher on avg = 2 words)

Author	Study design & Aims	Methodology	Intervention (Type of E Book Used/special characteristics)	Sample size, Age & Gender	Measures used	Outcomes Reported
		4. Control group - children played maths games on a computer.	Children were also able to search for hotspots themselves with a 30 sec time limit to prevent distraction.	Gender: M = 68, F = 68	Post Test: Story retelling	Word learning gains were higher for interactive animated e-book group (8% higher on avg = 4 words)
		Eight sessions took place over 4 weeks (2 per week), story order was randomised.		Location & Language: Holland & Dutch	Fidelity reported: Yes - 1 TvK score, 12 story comprehension and 11 story retellings omitted due to technical issues.	Target vocabulary scores in the interactive animated e-book group were not significant for time or exposure.
		Delivered by - researchers were in the room and only encouraged engagement		SES: Middle	Follow up Measures: None	

Appendix 1C: Weight of Evidence Information

1C.1 Weight of Evidence A (WoE A) – Methodological quality coding protocol and adaptations with rationale

As all the studies in this review were experimental or quasi-experimental group designs, their methodological quality (WoE A) was rated using the Gersten et al. (2005) criteria for evaluating evidence. However, as this framework and the resulting definitions are tentative, Gersten et al, (2005) suggests that they are refined for individual research projects. Therefore to reflect the specific methodological aspects of the studies in this review some of the quality indicator questions were adjusted as follows;

Essential Quality Indicators

- Question 1 – changed to highlight the descriptives available for the participants as a normative sample was required.
- Question 3 – changed to enable the role of researchers or teachers to be compared across the studies.
- Question 3 – Separated into two distinct questions to enable greater clarity between the studies.
- Question 10 - Separated into two distinct questions to enable greater clarity between the studies.

Desirable Quality Indicators

- Question one – Wording amended to reflect the lack of attrition in the studies due to the nature of the methodology, setting and age of participants.
- Question two - Separated into three distinct questions to enable greater clarity between the studies.
- Question five - Separated into two distinct questions to reflect the specific aspects of fidelity in the studies being reviewed.

The resulting grading definitions of the criteria were adjusted to create a high, medium and low weighting (See Table 1.9). This created a bespoke evaluation criteria that has been designed with reference to the relevant empirical evidence by the reviewer. Table 1.10 details the application of the coding protocol and the evaluation rating for each study.

Table 1.9

Criteria for WoE A weighting ratings

For a high rating of 3	For a medium rating of 2	For a low rating of 1
Study will:	Study will:	Study will:
Meet \geq 9 essential criteria	Meet \geq 9 essential criteria	Meet \geq 9 essential criteria
Meet \geq 7 desirable criteria	Meet $>$ 4 desirable criteria	Meet \leq 4 desirable criteria

Note: If there is insufficient information to be able to code a specific criteria it will be coded as not meeting the criteria

Table 1.10

Coding rubric for methodological quality of research papers using Gersten et al, (2005) coding protocol

Author	Broemm el Moran, & Wooten, (2015)	Kelley ,& Kinne y(201 7)	Lee, (2017)	Smeets & Bus, (2012a)	Smeets & Bus, (2012b)	Smeets & Bus, (2015)	
Essential Quality Indicators							
<i>Quality Indicators for Describing Participants</i>							
1	Was sufficient information provided to determine/confirm whether the participants demonstrated any disability(ies) or difficulties?	Yes	Yes	Yes	Yes	Yes	Yes
2	Were appropriate procedures used to increase the likelihood that relevant characteristics of participants in the sample were comparable across conditions?	Yes	Yes	Yes	Yes	Yes	Yes
3	Was sufficient information given characterizing the role of the teachers or researchers provided?	Yes	Yes	No	Yes	No	Yes
4	Was sufficient information given to indicate if the role of the teachers or researchers was comparable across conditions?	Yes	Yes	No	No	No	Yes
<i>Quality Indicators for Implementation of the Intervention and Description of Comparison Conditions</i>							
5	Was the intervention clearly described and specified?	Yes	Yes	Yes	Yes	Yes	Yes
6	Was the fidelity of implementation described and assessed?	Yes	Yes	No	No	No	Yes
7	Was the nature of services provided in comparison conditions described?	Yes	Yes	Yes	Yes	Yes	Yes

Author	Broemm el Moran & Wooten, (2015)	Kelley& Kinney (2017)	Lee, (2017)	Smeets & Bus, (2012a)	Smeets & Bus, (2012b)	Smeets & Bus, (2015)
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Essential Quality Indicators

Quality Indicators for Outcome Measures

8	Were multiple measures used to provide an appropriate balance between measures closely aligned with the intervention and measures of generalized performance?	Yes	Yes	Yes	Yes	Yes	Yes
9	Were outcomes for capturing the interventions effect measured at the appropriate times?	Yes	Yes	Yes	Yes	Yes	Yes

Quality Indicators for Data Analysis

10	Were the data analysis techniques appropriately linked to key research questions and hypotheses?	Yes	Yes	Yes	Yes	Yes	Yes
11	Were the data analysis techniques appropriately linked to the unit of analysis in the study?	Yes	Yes	Yes	Yes	Yes	Yes
12	Did the research report include not only inferential statistics but also effect size calculations?	No	Yes	Yes	Yes	Yes	Yes

Number of indicators met out of 12	11	12	9	11	9	12
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Desirable Quality Indicators

1	Where missing test results reported in the final outcomes?	Yes	Yes	No	No	No	Yes
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Author	Broemm el Moran & Wooten, (2015)	Kelley& Kinney (2017)	Lee, (2017)	Smeets & Bus, (2012a)	Smeets & Bus, (2012b)	Smeets & Bus, (2015)	
Desirable Quality Indicators							
2	Did the study provide internal consistency reliability but also test-retest reliability?	No	Yes	No	No	No	Yes
3	Did the study report interrater reliability (when appropriate) for outcome measures?	No	Yes	No	No	No	Yes
4	Were data collectors and/or scorers blind to study conditions and equally (un)familiar to examinees across study conditions?	No	Yes	No	No	No	No
5	Were outcomes for capturing the intervention's effect measured beyond an immediate post-test?	No	No	No	No	No	Yes
6	Was evidence of the criterion-related validity and construct validity of the measures provided?	No	No	No	Yes	No	Yes
7	Did the research team assess surface features of fidelity implementation (e.g., number of minutes allocated to the intervention or teacher/interventionist following procedures specified)?	Yes	Yes	No	No	No	No
8	Did the research team assess quality of implementation?	Yes	Yes	No	No	No	No
9	Was any documentation of the nature of instruction or series provided in comparison conditions?	Yes	Yes	No	No	No	No

Author	Broemm el Moran & Wooten, (2015)	Kelley& Kinney (2017)	Lee, (2017)	Smeets & Bus, (2012a)	Smeets & Bus, (2012b)	Smeets & Bus, (2015)	
Desirable Quality Indicators							
10	Did the research report include illustrations that capture the nature of the intervention?	Yes	No	No	Yes	Yes	Yes
11	Were results presented in a clear, coherent fashion?	Yes	Yes	Yes	Yes	Yes	Yes
Number of indicators met out of 11		6	8	1	3	2	7
Quality of study rating		2	3	1	1	1	3
Descriptive Quality of the Study		Medium	High	Low	Low	Low	High

Note: Yes = quality indicator met; No = quality indicator not met or insufficient evidence to code this indicator.

1C.2 Weight of Evidence B (WoE B) – Relevance of the Research Methodology

To evaluate if the design of the studies were appropriate for examining the impact of reading e-books on vocabulary acquisition, the study’s designs were assessed using the Gray (1997) matrix (see Table 1.11).

Table 1.11

Criteria and rationale for WoE B

Type of Design	Rating	Rationale
Randomised control trial	3	The types of design are ranked for their appropriateness of evaluating “effectiveness” in studies with randomised control trials considered the most appropriate for the review question.
Quasi Experimental & Cohort Studies	2	
Non experimental evaluations, surveys & qualitative research, Case control studies	1	

1C.3 Weight of Evidence C (WoE C) – Relevance for the review question

To explore the relevance of the studies and their findings (WoE C) to the review question the following criterial and rationale were used:

- Participants should be evaluated for vocabulary skills pre intervention to provide a baseline measurement enabling effectiveness to be evaluated.
- Participants should be matched on demographics (age, gender, SES) to ensure that any impact these have on the results can be identified. Young children's emergent literacy skills can vary considerably and impact on the results of the studies irrespective of the intervention used (Salmon, 2014).

- The study should be conducted in a pre-school or primary school setting to ensure replicability by school staff in a typical school setting.
- The same stories should be used across all conditions with just the format of delivery (print or e-book) varying to ensure that the effectiveness of the e-book in promoting vocabulary learning is being evaluated.
- Interactive features are an aspect of e-books that differentiates them from printed books and should be explicitly detailed in the studies. As the review is looking at the potential of e-books to impact on learning, this aspect of them is significant to the outcomes.
- Pre and post measures of receptive and expressive vocabulary should be gathered through the use of valid and reliable measures to enhance the validity of the findings.

To receive a 3 (high) WoE C rating a study must meet all of the above criteria, for a 2 (medium) rating at least four of the criteria should be met. For a study to be rated as 1 (low) it must meet at least one of the criteria, if none of the criteria are met a score of 0 (no evidence) will be given.

Table 1.12*Criteria and rating of studies for WoE C*

	Broemmel , Moran & Wooten, (2015)	Kelley & Kinney, (2017)	Lee, (2017)	Smeets & Bus, 2012a)	Smeets & Bus, 2015)	Smeets & Bus, 2012b)
Participants were evaluated for vocabulary skills pre intervention.	Yes	Yes	Yes	Yes	Yes	Yes
Participants were matched on demographics (age, gender, SES) across groups.	Yes	Yes	Yes	No	No	Yes
The study was conducted in a pre-school or primary school setting.	Yes	Yes	Yes	Yes	Yes	Yes
The same stories were used across all conditions with just the format of delivery (print or e-book) varying.	Yes	Yes	No	No	No	Yes
Interactive features were explicitly detailed in the studies.	Yes	Yes	No	Yes	Yes	Yes
Pre & post measures of receptive and expressive vocabulary reported.	Yes	Yes	No	Yes	Yes	Yes
Quality of study rating	3	3	1	2	2	3
Descriptive Quality of the Study	High	High	Low	Medium	Medium	High