Case Study 1: An Evidence-Based Practice Review Report

Theme: School (setting) based interventions for children with special educational needs (SEN)

How effective are computer or tablet -based reading interventions in raising reading standards for poor readers or those at -risk of reading difficulties?

1. Summary

Pupils with low reading attainment at the end of primary school are at higher risk of poor performance across a range of subjects in secondary school (Brännlund et al., 2017). Poor reading skills are associated with weak phonological awareness (Carroll et al., 2011). One resource to support phonological acquisition and reading development is computer or tablet-based reading interventions. They offer personalised learning dependent on the needs of the individual and provide high-levels of autonomy for the learner, resulting in increased motivation to engage in content (Cheung & Slavin, 2012). Prior reviews have focused on a broader sample of pupils with reading difficulties (Alqahtani, 2020) however, this review exclusively examined the effectiveness of computer or tablet-based interventions in improving the reading skills of those described as poor readers or at-risk of reading difficulties. Five studies met the inclusion criteria for the current review and were evaluated via Gough s (2007) Weight of Evidence framework to critically appraise their methodological rigour and applicability in answering the research question. Through this analysis, limited evidence was found for the exclusive use of computer or tablet-based interventions to improve reading outcomes for this at-risk group. These findings are discussed in more detailed alongside recommendations for further research and practice implications.

2. Introduction

In the United Kingdom (UK), one in four children leave primary school unable to read to the required standard (Department for Education [DfE], 2019). Poor reading at this age results in reduced academic engagement and motivation (Rabiner et al., 2016), and leaves pupils unable to benefit from opportunities for learning through reading. Reading below the expected standard is also negatively associated with mental wellbeing (National Literacy Trust, 2018) and poor educational attainment in secondary school (Brännlund et al., 2017). Therefore, because many reading difficulties can be prevented by early, intensive intervention, it is necessary to determine appropriate support in primary schools (Partanen & Siegel, 2013; Wanzek et al., 2018). Vital to the process of becoming a successful reader are phonological skills, which aid sight-reading accuracy (Carroll et al., 2011; Ehri et al., 2001; Department for Education and Skills, 2006(m)-3 (i)6 ()]TJ(.3 Td [(et)2.1 (J(.3 Td [(et16 (og)10n Li)6

Students motivation to engage in learning tasks effects their attainment and progress (Gottfried, 1985). Effective teaching provides engaging tasks for students and increases their motivation to learn. As explored through the self-determination theory of motivation (Cook & Artino, 2016), if a child is extrinsically motivated to complete a task, they may do so because they want to earn a reward or avoid punishment. Subsequently, motivation for task completion is out of their control and driven by external factors. However, when intrinsically motivated, a child will complete a task because of the sense of personal satisfaction task-completion may bring. They feel a sense of personal motivation and will attribute task completion, and subsequent success or failure, to be in their control. Due to their design, computer or tablet-based intervention can trigger this intrinsic motivation. They intend to provide the appropriate level of challenge and target specific needs therefore, increasing pupils feelings of autonomy over their learning and motivation for task completion (Cheung & Slavin, 2012).

Computer and tablet-based interventions targeting phonological skills, and their impact on at-risk students reading attainment, is less researched than their impact on other groups. Recent reviews have explored impact on general population (Ostiz-Blanco et al., 2021) or those with a range of reading difficulties, such as dyslexia (Alqahtani, 2020). As poor readers, in the early stages of primary school, are more like to develop future reading difficulties and have poorer long-term attainment, it is important to conduct a review based solely on this at-risk sample. For this group, computer or tablet-based interventions may be more motivating as they provide a level of learning autonomy not provided by traditional teaching methods. They are

3. Critical Review of the Evidence Base

A systematic review of the literature was conducted on the 6th January 2022 using three electronic databases, ERIC (EBSCOhost), PsycInfo and Web of Science. Specific search terms used are outlined in Table 1. Searches were conducted with written in English and written after 2013 as search criteria and terms were searched under abstract and title for all databases.

Table 1

Figure 1

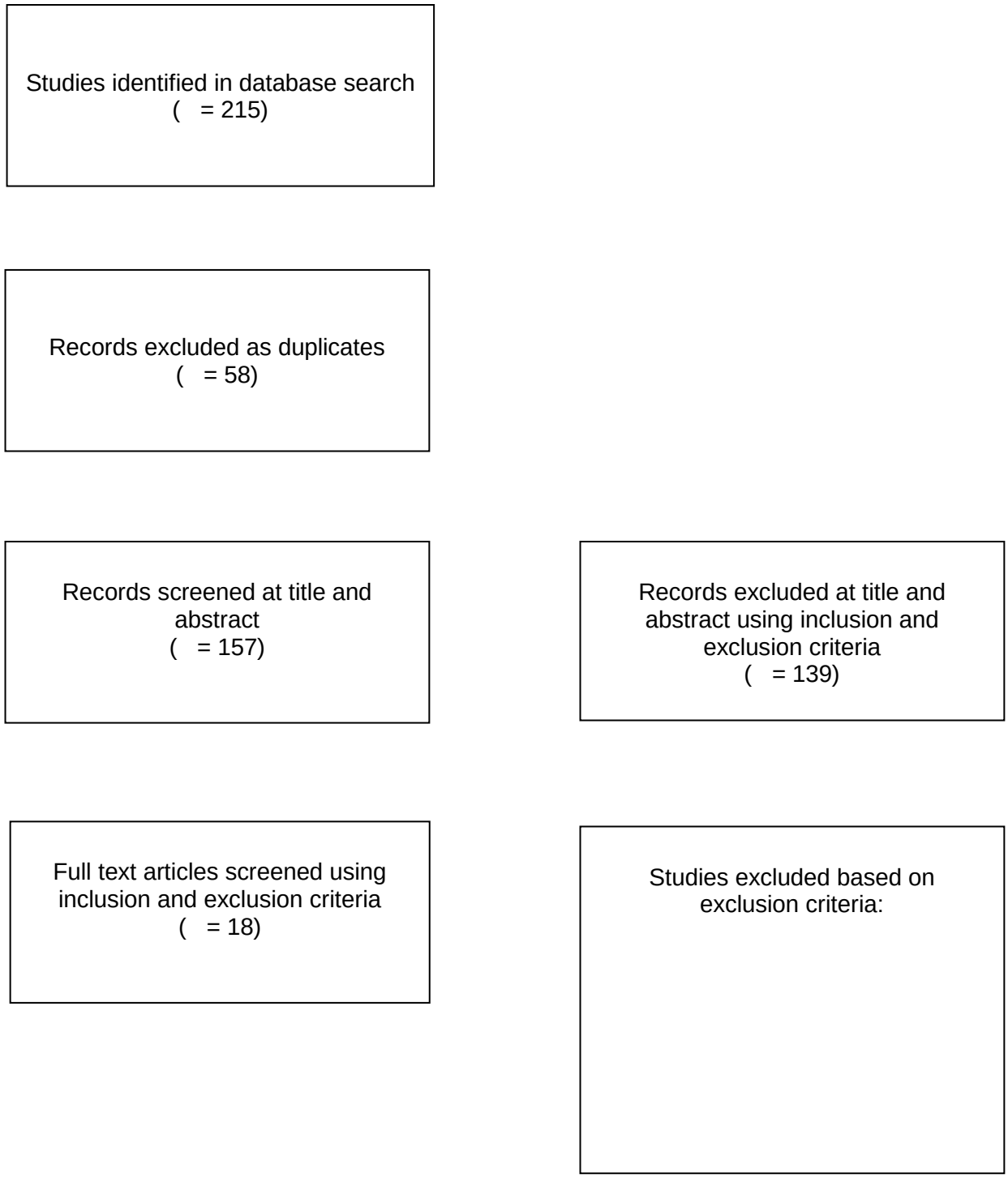
Studies identified in database search
(= 215)
Records excluded as duplicates
(= 58)
Records screened at title and abstract
(= 157)
Records excluded at title and abstract using inclusion and exclusion criteria
(= 139)
Full text articles screened using inclusion and exclusion criteria
(= 18)
Studies excluded based on exclusion criteria:

Table 2

Criteria	Inclusion	Exclusion	Rationale
1. Population	Primary-aged children identified as low performing or at-risk of reading difficulties	Typically developing primary-aged children	This review is looking specifically at poor readers or those at-risk of reading difficulties
2. Setting	Mainstream schools in an Organisation for Economic Co-operation and Development (OECD) country	Non-mainstream schools Schools not in an OECD country	To ensure that review findings can be generalised to UK primary school population (Gersten et al., 2005)

Criteria	Inclusion	Exclusion	Rationale
6. Language	Studies published in English	Studies not published in English	Researcher has a limited ability to accurately translate and interpret articles into English
7. Outcome measure	Studies must use a measure of reading	Any other outcome measure	The focus of this review is on reading outcomes
8. Publication	Studies have been published in a peer-reviewed journal	Studies not published in a peer review journal	As part of the reviewing process, studies published in a peer-reviewed journal, have high-levels of internal validity and originality (Kelly et al., 2014)

Table 3

Full Study Reference
D Agostino, J. V., Rodgers, E., Harmey, S., & Brownfield, K. (2016). Introducing an iPad app into literacy instruction for struggling readers: Teacher perceptions and student outcomes. (4), 522 548. https://doi.org/10.1177/1468798415616853
Kreskey, D. D., & Truscott, S. D. (2015). Is Computer-Aided Instruction an Effective Tier-One Intervention for Kindergarten Students at Risk for Reading Failure in an Applied Setting? (2), 142 151. https://doi.org/10.1007/s40688-015-0056-8
Messer, D., & Nash, G. (2017). An evaluation of the effectiveness of a computer-assisted reading intervention. (1), 140 158. https://doi.org/10.1111/1467-9817.12107
Rosas, R., Escobar, J.-P., Ramírez, M.-P., Meneses, A., & Guajardo, A. (2017). Impact of a computer-based intervention in Chilean children at risk of manifesting reading difficulties / Impacto de una intervención basada en ordenador en niæos chilenos con riesgo de manifestar dificultades lectoras. (1), 158 188. https://doi.org/10.1080/02103702.2016.1263451
Storey, C., McDowell, C., & Leslie, J. C. (2019). Headsprout Early Reading for Specific Literacy Difficulty: A Comparison Study. . https://doi.org/10.1007/s10864-019-09336-7

Table 4

Studies	WoE A	WoE B	WoE C	WoE D
D Agostino et al. (2016)	2 (Medium)	2 (Medium)	1.7 (Low)	1.9 (Low)
Kreskey & Truscott (2015)	1 (Low)	2 (Medium)	2 (Medium)	1.7 (Low)
Messer & Nash (2016)	3 (High)	3 (High)	2.7 (High)	2.9 (High)
Rosas et al. (2017)	1 (Low)	2 (Medium)	1.7 (Low)	1.6 (Low)
Storey et al. (2019)	2 (Medium)	2 (Medium)	2.3 (Medium)	2.1 (Medium)

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The five studies in this review included 337 participants from OECD countries. Two studies Messer & Nash, 2016; Storey et al., 2019 included participants from the UK, which is reflected in their WoE A rating and increased generalisability of findings to the UK school context. In accordance with inclusion criteria, all participants were of primary age and all interventions took place in a school setting. Each study included a sample of pupils either at-risk of reading failure or those making poor progress in reading. Within their inclusion criteria, two studies (Kreskey & Truscott, 2015; Rosas et al., 2017) sampled pupils of reduced socio-economic status. Subsequently, results from these studies can only be generalised to this specific population, which contributed to their low WoE A rating.

intervention, whereby trained teachers focused on pupils phonetic understanding using an iPad application. Whilst this study clearly described intervention implementation frequency and monitoring, which contributed to its medium WoE A rating, it used a technology-app to complement existing intervention. As a result, this study was deemed less applicable in answering the review question, which resulted in a low WoE C rating.

All studies measured either phonological acquisition or word-reading accuracy, either using standardised assessments D Agostino et al., 2016; Kreskey & Truscott, 2015, Messer & Nash, 2016; Storey et al., 2019) or curriculum-based measures (Rosas et al., 2017). Two studies determined social validity via interview (D Agostino et al., 2016) or questionnaire (Storey et al., 2019). Due to this review s focus on reading accuracy, and the inclusion criteria pertaining to experimental design, this qualitative data was not further explored. Three studies (D Agostino et al., 2016, Messer & Nash, 2016; Storey et al., 2019) used either blind assessors or determined inter-observer s agreement when scoring pre- and post-intervention measures. This limited any inadvertent data collection bias thus strengthening their internal validity (Gersten et al., 2005) and contributing to their medium and high WOE A ratings (see Appendix B).

A description of each study s outcome measure and effect sizes are detailed in Table 5. Cohen s d (Cohen, 1988) effect size was reported for three studies (D Agostino et al., 2016; Messer & Nash, 2016; Storey et al., 2019) reflected in their medium to high

WOE A ratings. The remaining two studies (Kreskey & Truscott, 2015; Rosas et al., 2017), did not report effect sizes. Therefore, these were calculated using the Campbell Collaboration Calculator (Wilson, 2022) via means and standard deviations from post-intervention data (see Appendix F for further information).

Three of the studies (D Agostino et al., 2016; Messer & Nash, 2016; Storey et al., 2019) reported large effect sizes for at least one measure supported by statistically significant differences between pre-and post-data for each intervention (see Table 5 for further detail). Therefore, suggesting that the interventions resulted in a significant change in reading accuracy for the intervention group comparative to the control group. The Storey et al. (2019) study reported a very large effect size (Sullivan & Feinn, 2012). Due to the study s small sample size and unequal intervention and control samples, these results need to be interpreted with caution (Slavin & Smith, 2009).

The remaining studies (Kreskey & Truscott, 2015; Rosas et al., 2017) reported small to medium negative effect sizes, indicating that post intervention results were lower than those pre-intervention. Three subsets of the Dynamic Indicators of Basic Early Literacy Skills (DIBELS) were used in the Kreskey and Truscott (2015) study to determine reading accuracy. However, only two subsets were reported post-intervention, meaning intervention effectiveness could not be determined across all measures. These unclear, incoherent results contributed to its low WoE A rating. The Rosas et al. (2017) study reported effect sizes for all curriculum-based measures used. However, significant differences were reported between intervention and control groups pre-intervention. Therefore, effects cannot be solely attributed to inclusion in the intervention and need to be interpreted with caution.

Study	Measure of reading accuracy	Number of participants	Sample	Effect size (d) (within groups, pre-post test)	Descriptor	Significance values	WOE D

the intervention. Furthermore, neither study reported any long-term follow-up effects, therefore, it is unclear whether these interventions had a positive, long-term effect on sentence reading or phonological decoding. In contrast, the very large effect sizes reported in the Storey et al. (2019) study were based on significant increases in single word reading and sentence reading skills. This suggests that general reading skills also improved as a result of the intervention and that this intervention could be recommended to support acquisition of general reading skills. Although, yet again, follow-up data was not reported so the overall, long-term impact on reading outcomes cannot be ascertained.

Furthermore, although the remaining two studies (Kreskey & Truscott, 2015; Rosas et al., 2017) reported negative effect sizes, they also had lower, methodological quality as evidenced through their low WoE A ratings and low overall WoE D rating. (

conducted by school staff, they may not garner the same results. Therefore, reported effect sizes need to be interpreted with caution due to limited generalisability of findings and implementation to school contexts. The D Agostino et al. (2016) study, randomised teachers to the experimental and control conditions to try to control differences between groups. However, teacher implementation proficiency was not assessed or evaluated at any time. Subsequently, the impact of individual teacher ability to deliver the programme acted as an uncontrolled variable. This means that results cannot be wholly attributed to the intervention as teacher effectiveness may have influenced outcomes.

A suggested benefit of computer or tablet-based interventions is their cost-effectiveness, as they require limited staff-pupil interaction. A further limitation of this review was each study s inability to define whether the intervention was conducted with minimal staff input or if it was complemented by additional one-to-one intervention. Studies (D Agostino et al., 2016; Messer & Nash, 2017; Storey et al., 2019), which reported large effect sizes, also included more interaction between students and intervention facilitator than those reporting smaller, negative effect sizes (Kreskey & Truscott, 2015; Rosas et al., 2017). Within the Messer and Nash (2017) study, staff provide an unspecified level of individual attention to pupils who struggled. Whereas the Story et al. (2019) study included an element of independent reading post-session, without reported clarity on the specific skills targeted in these sessions. This means that improvements cannot be entirely attributed to the computer-based intervention and that the interventions required higher staff input, equating to higher running costs.

In schools, highly valued amongst school staff is an EPs ability to recommend of strategies to support pupils (Ashton & Roberts, 2006). However, EPs need to ensure that the practice shared is based on evidence of its effectiveness (Fox, 2003). While several studies within this review, with high WoE D ratings, found that computer or tablet-based interventions can be used to improve reading outcomes for poor readers or those at-risk of reading difficulties, due to the limiting factors discussed, there is insufficient evidence for EPs to recommend their use for this at-risk group.

As a rationale for their use, all studies suggested computer or tablet-based interventions to be more motivating for students than traditional methods. Using anecdotal evidence from those implementing the intervention, D Agostino et al. (2016) considered the inherent motivational qualities of tech-based interventions as a key mediating factor in letter-knowledge acquisition for the intervention group. Although the specific contributing, motivational features, were not specified, Messer and Nash (2016) suggested the trialled intervention s ability to adapt to individual pupil knowledge as a key factor in promoting pupil motivation when [illegible]

5. References

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Appendices contents list

Appendix A

Appendix B

Gersten et al. s (2005) non-review specific coding protocol was used to determine the methodological quality of each study, generating a WoE A. As this framework, and resulting sub-categories are non-review specific, Gertsen et al. (2005) suggests that they can be adapted dependent on research project. Therefore, one of the desirable quality indicators was adapted accordingly (see Table 1 for further detail). Subsequently, each study was coded using the adapted coding protocol (see Table 2 for evidence of each study s coding). Coding was completed, using the Gersten et al. (2005) defined criteria (see Table 3) and each study was given a final WOE A rating (see Table 4).

Table 1

Desirable Quality Indicator	Rationale

Author	D Agostino et al. (2016)	Kreskey & Truscott (2015)	Messer & Nash (2017)	Rosas et al. (2017)	Storey et al. (2019)
2. Was the fidelity of implementation described and assessed?	Yes	No	Yes	Yes	Yes
3. Was the nature of services provided in comparison conditions described?	Yes	Yes	Yes	Yes	Yes
1. 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
2. Were outcomes for capturing the intervention s effect measured at the appropriate times?	Yes	Yes	Yes	Yes	Yes

Author	D Agostino et al. (2016)

Author	D Agostino et al. (2016)	Kreskey & Truscott (2015)	Messer & Nash (2017)	Rosas et al. (2017)	Storey et al. (2019)
2. Did the study provide not only internal consistency reliability but also test retest reliability and interrater reliability (when appropriate) for outcome measures? Were data collectors and/or scorers blind to study conditions					

Author	D Agostino et al. (2016)	Kreskey & Truscott (2015)	Messer & Nash (2017)	Rosas et al. (2017)	Storey et al. (2019)
6. Was any documentation of the nature of instruction or series provided in comparison conditions?	Yes	No	No	No	No
7. Did the research report include actual audio or videotape excerpts that capture the nature of the intervention?	No	No	No	No	No
8. Were results presented in a clear, coherent fashion?	Yes	No	Yes	Yes	Yes
Number of desirable indictors met out of 9	3	0	5	1	3

Table 3

WoE A Rating	Criteria
3 (High)	1. Study meets a9 or more of the essential quality indicators 2. Study meets 4 or more of the desirable quality indicators
2 (Medium)	1. Study meets at 9 or more of the essential quality indicators 2. Study meets between 1 and 3 4 of the desirable quality indicators
1 (Low)	1. Study meets at 9 or less of the essential quality indicators

Table 4

Study	Essential criteria met	Desirable criteria met	WoE A rating
D Agostino et al. 2016	10	3	2 (Medium)
Kreskey & Truscott, 2015	6	0	1 (Low)
Messer & Nash, 2016	10	5	3 (High)
Rosas et al. 2017	8	1	1 (Low)
Storey et al. 2019	10	3	2 (Medium)

Appendix C

WoE B is a review-specific judgement to determine the appropriateness of a study s design in answering the review question. When determining this, typologies are preferable to hierarchies as they consider the type of study required to answer a specific review question. Table 1 illustrates the preferred study type to determine an intervention s effectiveness derived from a pre-existing typology of evidence (Petticrew & Roberts, 2003). Table 2 provides the WOE B rating for each study.

Table 1

Study Design	WoE B rating	Rationale
Randomised controlled trial (RCT)	3 (High)	To determine the effectiveness of a specific-type of intervention, RCTs are considered the most robust study design.
Quasi-experimental and cohort studies	2 (Medium)	
Qualitative research, survey, case-control studies and non-experimental evaluations	1 (Low)	

Table 2

Appendix D

WoE C is a review-specific judgement regarding how relevant each study and its findings are in answering a review question. Table 1 outlines the specific criteria used for this review with a rationale for each. Table 2 provides the WoE C rating for each study.

Table 1

Criteria	WoE Rating	Descriptor	Rationale
Location of intervention	3	UK schools	
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Criteria	WoE Rating	Descriptor	Rationale
Outcome measures, reliability and validity	3	High reliability and validity reported for outcome measures	
	2	An element of reliability or validity reported for most outcome measures	
	1	Reliability and validity of outcome measures not reported	

Table 2

Study	Location of Intervention	Intervention	Outcome measures, reliability and validity	Overall WoE C Rating and Qualitative Descriptor
D Agostino et al. (2016)	2	1	2	1.7 (Low)
Kreskey & Truscott (2015)	2	2	2	2 (Medium)
Messer & Nash (2016)	3	2	3	2.7 (High)
Rosas et al. (2017)	2	2	1	1.7 (Low)
Storey et al. (2019)	3	2	2	2.3 (Medium)

Appendix E

Author	Study design	Geographical distribution	Participants	Intervention investigated	Context of intervention	Outcome variables measured (relevant to the review question)
D Agostino et al.(2016)	Experimental study with a double random assignment	USA	Sample: = 50 (treatment = 25, control = 25) Age: First-grade students (6-7yrs)	Reading recovery using the Letter-works app	Facilitators: Reading recovery teachers Time: During school day Pre-post: 20weeks	Dynamic Indicators of Basic Literacy Skills, Sixth Edition (DIBELS) Observation Survey of Early Literacy Achievement (OSELA)

Author	Study design	Geographical distribution	Participants	Intervention investigated	Context of intervention	Outcome variables measured (relevant to the review question)