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Building word knowledge, learning strategies, and metacognition with the Word-Knowledge e-Book

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ABSTRACT

Many children fail to comprehend what they read because they do not monitor their understanding, which requires making accurate judgements of what they know and then employing repair strategies when comprehension fails. Relying on research from learning science and cognitive and developmental psychology, we developed the Word Knowledge e-Book (WKe-Book) to improve children's calibration of their word knowledge, strategy use, and word knowledge overall; skills which are associated with reading comprehension. The WKe-Book, which is read on a tablet computer, is a choose-your-own adventure book where choices require choosing between two rare words (e.g., cogitate vs. procrastinate). Depending on the word chosen, the story follows a different plot. There are also embedded comprehension questions where students receive immediate feedback with consequences for incorrect answers, such as being sent back to reread a few pages. In a randomized controlled trial, we tested whether students (N = 603 in 25 third through fifth grade classrooms in Arizona in the US) reading the WKe-Book would demonstrate improved word knowledge, strategy use, and word knowledge calibration. Classrooms were randomly assigned to read the WKe-Book immediately (treatment) or later (delayed-treatment control), and within classrooms, students were randomly assigned to either participate in a 15-min weekly book club (book club treatment) or to read the WKe-Book independently with no book club (no book club control). Results revealed a significant treatment effect of the WKe-Book on students' word knowledge, word knowledge calibration, and strategy use, which predicted student performance on standardized reading comprehension and vocabulary measures. The effects were greater for students who participated in weekly book clubs compared to students in the no book club control. These findings suggest that the affordances offered by technology, which are unavailable in paper-based books, can support students' development of metacognition, including word knowledge calibration, strategy use, and word learning skills.

1. Introduction

E-books have become ubiquitous in schools and homes. Many schools are investing in iPads and other tablet computers with the intention that these technologies will provide students greater access to e-books, apps, and other online resources. A 2014 survey showed that 63% of school libraries had e-books, with a 325% increase from 2010 in the number of different titles offered, with the

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greatest increase being in elementary schools (Sun, 2014). A meta-analysis (Sung, Chang, & Liu, 2016) reviewing the impact of mobile technology in education revealed an overall positive effect on student learning during elementary school years, with the effect size of 0.65, which is large for education interventions (Hill, Bloome, Black, & Lipsey, 2008). However, the use of e-books has largely preceded research on exactly which affordances will effectively support younger readers, especially those from third to fifth grade who are increasingly expected to learn from the texts they are reading (Felvégi & Matthew, 2012). Reading comprehension is a critical skill in today's information-based society. Evidence suggests that this is a teachable skill (NICHD National Reading Panel, 2000), yet one that too many students fail to achieve. By fourth grade, one third of America's children fail to read proficiently (NAEP, 2015). Poor reading comprehension represents a serious problem and is associated with higher rates of referral to special education, juvenile delinquency, and school dropout (Reynolds, Temple, Robertson, & Mann, 2002).

Although there are conflicting findings on the effects of technology on students' learning outcomes (e.g., Warschauer, Zheng, Niiya, Cotten, & Farkas, 2014), the promise of technology to enhance students' learning is compelling. Thus, this randomized controlled study was designed to examine the efficacy of an interactive e-book, called the Word Knowledge e-Book (WKe-Book), when implemented in the classroom, to improve elementary school students' metacognitive skills, specifically their conscious strategy use, word knowledge calibration, word knowledge, and in turn their reading comprehension proficiency. Additionally, the study was designed to examine how a teacher-led book club might enhance students' technology-based learning.

1.1. Developing the WKe-Book Design and theories

1.1.1. Review of the literature on E-Books

Before beginning to design and develop the WKe-Book, we carefully reviewed the research literature on e-books for third to fifth graders (8- to 11-year-olds) and found a number of studies that helped to inform which affordances to target in the WKe-Book and to guide development efforts (see Appendix A). Of the 22 studies we reviewed, the majority of studies targeted younger (3- to 7-year-olds) or older (11- to 12-year-olds) students. None targeted our intended age group of 8- to 11-year-olds. There were, however, some common themes across studies. First, where paper books and e-books were compared, results tended to favor e-books with regard to student engagement and reading outcomes (e.g., Krcmar & Cingel, 2014). One study examining sixth grade students' retrieval rates for science texts, found that retrieval rates were greater for those using an e-book compared to those reading the paper version (Liang & Huang, 2013). Moreover, access to an online dictionary was an affordance consistently associated with stronger student outcomes (e.g., Korat, Levin, Atishkin, & Turgeman, 2014).

Takacs and colleagues (Takacs, Swart, & Bus, 2015) concluded in their meta-analysis of 29 studies that e-books, outfitted with interactive multimedia features, can improve students' reading comprehension and vocabulary gains in ways similar to scaffolded storybook reading sessions with adults. These researchers posited that the *types* of affordances included in e-book programs may have differential impacts on student learning outcomes, distinguishing between enriching animations that promote understanding and overly-stimulating interactive features that distract from the core target skills. Specific affordances, such as increasing student autonomy, providing guided questioning, providing access to online dictionaries, and offering immediate feedback have been proposed as features that might further enrich the learning opportunities afforded by e-books (Biancarosa & Griffiths, 2012; Caplovitz, 2005; McKenna, Reinking, Labbo, & Kieffer, 1999). At the same time, in a recent meta-analysis (Sung et al., 2016), the overall effect of e-book readers (e.g., Kindles) on learning, broadly defined, was negative ($d = -0.70$, whereas the effect of more interactive apps used on tablet computers and handheld computers was much higher ($d = 0.61$ and 0.74, respectively). Our hypothesis related to this finding was that the rather linear organization of some e-book readers may not have been as effective as the more multi-dimensional organization of e-book apps (e.g., digital storybooks) with more interactive features. Thus, we planned to create the WKe-Book as a non-linearly organized e-book with interactive affordances (i.e., not an e-reader) that should support students' development of metacognition in the service of reading for understanding.

1.1.2. Improving students' reading comprehension – research from developmental and cognitive science

Generally recognized definitions of reading comprehension involve the reader's active extraction and construction of meaning from text (Anderson, Hiebert, Scott, & Wilkinson, 1985; NRP, 2000; Rand Study Group & Snow, 2001). The recently introduced lattice model (Connor, 2016), which informed the development of the WKe-Book, defines reading comprehension as a complex activity that requires the reader to call on the coordination of cognitive, regulatory, linguistic, and text-specific processes, including fluent decoding of text. Students' skills are developed over time, are improved by instruction, and have reciprocal and interacting bootstrapping effects on one another (Cain, 2006; Connor, 2016; Connor et al., 2016; Kim & Phillips, 2018; Kinnunen & Vauras, 2010; Perfetti & Stafura, 2014). The lattice model explicitly includes instruction as a key source of influence on children's developing text-specific, linguistic, and cognitive (and metacognitive) skills. Thus the lattice model presents learning to read as a complex system that includes the constellation of skills students bring to the classroom, the instruction they receive in the dynamic context of the classroom, and other proximal (home) and distal sources of influence (e.g., education policy; Bronfenbrenner & Morris, 2006; Yoshikawa & Hsueh, 2001). Below, we describe the three key processes the WKe-Book was developed to improve – text specific processes, linguistic processes, and cognitive processes, in the context of technology that is integrated into the classroom learning environment.

1.1.2.1. Text-specific processes. Text-specific processes are those that we develop only because we read and write. This includes the understanding that letters represent sounds in the language, which are blended to form meaningful words, as well as an awareness of text structure (Kendeou & van den Broek, 2007; Kim & Phillips, 2018), and genre specific knowledge (Ingebrand & Connor, 2016;

McNamara, Ozuru, & Floyd, 2011). When text-specific processes, particularly decoding, are not fluent and automatic, reading comprehension is weakened. This is because weak decoding skills act as a bottleneck, increasing cognitive load and leaving fewer cognitive resources available for reading comprehension (Kim, Samson, Fitzgerald, & Hartry, 2010; Rayner, Foorman, Perfetti, Pesetsky, & Seidenberg, 2001). Thus, sustained practice is an important element of gaining fluent text-specific skills and, hence, learning to read proficiently. One of the most important ways students gain fluent and automatic text-specific skills (i.e., fluency) is through sustained independent reading over time (O'Connor, White, & Swanson, 2007). Thus, we designed the WKe-Book to include motivational affordances to sustain students' engagement with the story, and hence increase the time they spent reading the text. Specifically, students named the main characters of the book and could make decisions about the direction of the plot using the choose-your-own adventure format. In addition, user-log data (i.e., clickstream data) enabled us to investigate and operationalize students' actual sustained independent reading. Notably, these affordances are much easier to implement with technology compared to paper books.

1.1.2.2. Linguistic processes. Given that vocabulary and word knowledge are among the strongest predictors of reading comprehension, we conjectured that improving children's word knowledge would also improve their comprehension. In this study, *vocabulary* refers to the size and depth of a student's lexicon, and *word knowledge* refers to their understanding of the semantic relationships between and among words, word connotations, and etymology. Word knowledge supports and is supported by strong vocabulary skills. Reading with comprehension requires students to have strong vocabulary skills, as well as word knowledge including an understanding of word families and how words are semantically related (Sénéchal & Cornell, 1993; Storch & Whitehurst, 2002). Once students have developed fluent text-specific skills, some studies have shown that it is the students' vocabulary and word knowledge that are the most significant predictors of reading ability (Perfetti & Stafura, 2014). Strong lexical and semantic representations allow students to quickly search their memory for word meanings in context, which can substantially influence the overall interpretation of the text (Perfetti, 2007). As students begin to comprehend and use words in context appropriately, they learn to understand the meaning of sentences and make connections between the meanings of multiple words and sentences (Graesser & McNamara, 2012; Kintsch, 1998; van den Broek, Risden, Fletcher, & Thorlow, 1996). Thus, according to most discourse comprehension models and models of reading, students' vocabulary and word knowledge are critical and synergistic skills for understanding text. The WKe-Book incorporates a number of features to support vocabulary and word knowledge learning, which are discussed more fully in Section 1.1.4.

1.1.2.3. Cognitive processes. Metacognition, arguably among the most important predictors of learning in general, is broadly conceptualized as the knowledge about and regulation of one's cognitive activities in learning processes (Flavell, 1979; Whitebread et al., 2010; Zimmerman, 1990). It concerns knowing and using strategies such as monitoring one's own thinking and engaging in active planning and evaluation. This ability to be a knowledgeable and active participant in one's own learning is crucial for all content areas, but has been directly linked to literacy for vocabulary, word knowledge, and reading comprehension (e.g., Boulware-Gooden, Carreker, Thornhill, & Malatesha, 2007). The act of both evaluating and regulating one's own comprehension when reading text is called comprehension monitoring (Bol & Hacker, 2012; Hacker, 1996). Although the terminology of comprehension monitoring might overlook the distinction between the two aspects of evaluation and regulation of comprehension, comprehension monitoring is not a unitary skill (L. Baker, 1984). Researchers have similarly defined comprehension monitoring as the conscious and unconscious strategies and skills used to (1) evaluate reading comprehension and identify inconsistencies that might occur during text reading and (2) regulate reading comprehension or repair the misunderstandings (Cain, Oakhill, & Bryant, 2004; Connor et al., 2015). Thus, there are two parts to reading comprehension monitoring: recognizing when text does not make sense (calibration), and then actively working to repair comprehension (strategy use). Calibration, in general, is defined as the specific ability to make judgements about whether one does or does not know something (Bol & Hacker, 2012).

One important metacognitive skill that is critical to reading comprehension monitoring, is students' *word knowledge calibration.* We define this as the students' conscious awareness of their ability to judge how well they know the meaning of a word. One reason that students run into difficulty making sense of the text they are reading is that they assign the incorrect meaning to a word with which they are unfamiliar. In order to repair understanding, they must first recognize that they do not know the meaning of a word. The next step: having decided they do not know the word, they then employ reading comprehension repair strategies to facilitate reading for understanding. Thus, we consider word knowledge calibration to be an essential part of comprehension monitoring. There is an extensive research literature on word learning as a key reading comprehension strategy (NICHD National Reading Panel, 2000; Perfetti & Stafura, 2014).

Low levels of word knowledge are associated with weaker calibration (Dunning, Johnson, Ehrlinger, & Kruger, 2003). Thus, strengthening word knowledge calibration without also increasing word knowledge may be ineffective in improving comprehension. We argue that the affordances we built into the WKe-Book, including the choose-your-own adventure format using unfamiliar words (e.g., adamant and vacillate), comprehension questions with feedback, along with game-like features including consequences for answering questions incorrectly and making poor decisions about the direction of the plot, would help students become more intentional about monitoring their understanding (i.e., calibration) and in their use of reading comprehension strategies to repair their misunderstanding.

Whether we can actually improve students' calibration through technology affordances, and whether the effect of being better calibrated leads to stronger reading comprehension has not been examined for third, fourth, and fifth graders, to the best of our knowledge. Again, according to the lattice model (Connor, 2016), metacognitive skills, including calibration and strategy use, act reciprocally with linguistic and text-specific processes, in the context of instruction, across and in real time to influence reading

comprehension, which in turn influences metacognitive and linguistic processes. Our study design allows for the testing of these predictions using measures of word knowledge calibration, word learning strategy use, and the utilization of these skills on a test of word knowledge, in conjunction with measures of vocabulary and reading comprehension in the context of a longitudinal randomized controlled intervention trial.

Taking the findings on e-books (see Appendix A) together with research studies on students' language and literacy development we determined that: (1) e-books are likely to be at least as effective and may be more effective than paper books for improving student engagement and, in some cases, reading outcomes, thus, we did not develop a paper version of the WKe-Book; (2) user-logs that track student reading rates may be informative for researchers and, potentially, teachers so we included the ability to record students' clicks and time spent on each page; (3) online dictionaries appear to support improved student learning outcomes, so we included instruction in how to access the iPad online dictionary; (4) in general, the more effective e-books have integrated intentional strategy use so we focused on specific strategies associated with improved reading comprehension; and (5) more research on third-fifth graders' use of e-books was warranted so we targeted this age group. We also strived to maintain opportunities for sustained reading of text (e.g., three pages of text with no interruptions; Simmons et al., 2008) but with interspersed interactive features designed to keep students interested and engaged in the story (Sung et al., 2016).

1.1.3. WKe-book development

We developed the WKe-Book using an iterative design approach (Connor et al., 2017). As the WKe-Book was being written, we worked closely with a small group of third to fifth grade students and their teachers. This allowed us to gather feedback from the students and teachers as each chapter was completed, and to make changes as needed. For example, students were asked to provide feedback on their general enjoyment of the story, the different story streams, target words, or how they felt about the consequences of answering a question incorrectly (being sent backwards to read the previous page(s)), and so forth. We carefully observed how the WKe-Book contributed to the learning environment of the classroom, gained insights from teachers, observed students' engagement with and progress through the WKe-Book, and asked students about their likes and dislikes regarding the WKe-Book. We observed students while they were reading the WKe-book in the classrooms to gain a better understanding of the affordances that appeared to improve students' persistence and engagement, and that tended to optimize classroom learning opportunities. The latter observations indicated that we might want to test the efficacy of a weekly book club, which we also developed during this initial phase. Teachers were involved in the development of the 15-min weekly book club, providing feedback and suggestions, which were incorporated into the lesson plans.

During development, we used the user-logs to better understand how the students proceeded through the book and where they seemed to disengage or lose interest. The logs tracked students' time spent on each page, sequence of pages read (e.g., do they go back and re-read?), and so forth. Thus, the implementation and the collected user-logs from the WKe-Book served as an excellent platform providing us rich data (R. S. J. D. Baker & Yacef, 2009) to inform theory and practice.

1.1.4. Word learning strategies

As noted previously, there is an extensive research literature on word learning as a key reading comprehension strategy (NICHD National Reading Panel, 2000; Perfetti & Stafura, 2014). Thus, an important aim of the WKe-Book development was to examine the assumption driven by learning science, as well as text and discourse models, that fluent and effective reading comprehension strategy use, including word learning strategies, helps students make appropriate inferences and decipher unknown words and challenging text, and to examine whether and which WKe-Book affordances might facilitate intentional strategy use (McNamara, 2007). As McKeown, Beck, and Blake (2009) point out, relating reading comprehension strategies to meaning is a critical part of the process of effective strategy instruction. That is, strategies taught in isolation were not as effective as teaching strategies to help students better understand the meaning of a specific sentence or paragraph (McKeown et al., 2009). Strategies provide the means to tackle complex problems in more efficient ways and, *with practice*, these strategies can lead to the development of relatively automatic reading comprehension skills that support reading for understanding. Word learning strategies are defined here as purposeful techniques taught to and employed by students that aid in the acquisition of new vocabulary and word knowledge. Strategies used for word learning are an integral component to successful literacy acquisition (Honig, Diamond, & Gutlohn, 2013). The National Reading Panel (NRP) identifies dictionary use, morphemic analysis, and contextual analysis as the three most prevalent word learning strategies taught in US schools today. These strategies are each supported by empirical research and are considered effective tools for word learning (NICHD National Reading Panel, 2000). Additionally, citing a strong evidence base, these strategies are recommended for academic vocabulary instruction among K–8 English learners (S. Baker et al., 2014). These three strategies were explicitly incorporated as affordances of the WKe-Book.

1.1.4.1. Dictionary use. Dictionary use is perhaps the most straightforward of the three strategies and most widely used in the e-book studies we reviewed; if students do not know the meaning of a word, they look it up in the dictionary. Looking up a word and fully processing its definition expands a student's word knowledge (Yanguas, 2009). Further, the more students are exposed to word definitions, the better they learn words over time (McKeown, Beck, Omanson, & Perfetti, 1983; McNamara, 2007). However, an important instructional aspect of this strategy is explicitly teaching students *when* to use the dictionary (which relates to word knowledge calibration) and *how to use* what they find in a dictionary entry. If students can effectively translate the components of a definition (i.e., part of speech, pronunciation, primary and secondary definitions) into working knowledge of a target word, they are better able to retain this knowledge for future use (Stahl & Nagy, 2000).

1.1.4.2. Morphemic analysis of words. Morphemic analysis of words involves the analysis of word-part clues to derive meaning about a word. In terms of explicit instruction, this involves teaching students the meanings of word parts, as well as teaching them how to disassemble and reassemble words (Baumann, Edwards, Boland, Olejnik, & Kame'enui, 2003). The use of the root word, prefixes, suffixes, and cognates for a given word is essential to this process, and many students learn more from explicit instruction in these concepts before they apply them to learning unfamiliar words. Once these concepts are mastered (the meaning of the root word and affixes are known), the meaning of unfamiliar words can be derived (Anglin, 1993; Biemiller & Boote, 2006). This strategy is especially well suited for generalizing word knowledge because the same affixes are used across a wide range of words (White, Sowell, & Yanagihara, 1989). White et al. (1989) found that students were better able to predict the definitions of unknown words after being explicitly taught lessons on morphemic word structure. Understanding morphemes also provides students with the tools necessary to become independent word learners. Thus, the feedback provided for the comprehension questions in the WKe-Book explicitly provides information about the root word and the meaning of prefixes and suffixes that change the meaning of the word. These strategies were also taught in the weekly book clubs.

Many of the students in our study are Spanish-speaking English learners (ELs). Understanding cognates and word history is particularly important for these ELs, for whom many unfamiliar words in English are common in Spanish (e.g., maleficent is the equivalent of malo in Spanish). Taking cognates that are similar across two languages and identifying the common meaning allows ELs to pick up basic word definitions (August, Carlo, Dressler, & Snow, 2005). Emphasizing cognate similarities and providing words in two languages improves vocabulary, word knowledge, and reading comprehension for ELs (Carlo et al., 2004). The WKe-Book provides explicit feedback about cognates for the comprehension questions (e.g., verdant-verde).

1.1.4.3. Contextual analysis. Contextual analysis is perhaps the most sparsely studied of the purposeful word learning strategies. There is compelling evidence that context plays a more incidental role in word learning, as opposed to the more concrete role played by strategies, such as the two previously discussed (Nagy & Scott, 2000; Swanborn & de Glopper, 1999). Because of this, little is known about whether teachers can enhance this "natural effect" through explicit instruction (Baumann et al., 2003). Despite the lack of research on purposeful instruction in this area, many believe that teaching children to attend to the clues given in the text before and after an unknown target word should prove effective in supporting word knowledge growth in students (Nagy, McClure, & Mir, 1997). Thus, in the WKe-book, unfamiliar words (e.g., vacillate) are provided in a rich context (e.g., Lakeisha vacillated. She didn't know what to do. Should she go with Jose or should she stay in the safety of the shelter?).

1.1.5. Research questions for the WKe-Book cluster randomized control trial

The purpose of the study presented here was to test, in a randomized controlled trial, whether the WKe-Book was effective in improving students' word knowledge calibration, intentional use of word-learning strategies, and word knowledge learning overall, compared to a control group of children. Thus, we conducted a cluster randomized controlled trial (RCT, Shavelson & Towne, 2002) during the 2014–15 school year using a delayed treatment design (see Fig. 2) with classrooms randomly assigned to use the WKe-Book immediately or to use it after the first cohort finished the WKe-Book (delayed treatment control group). Student assessments at the mid-point provided the outcomes for the RCT.

Within classrooms, students were randomly assigned to participate in a weekly book club or to a no book club control (i.e., they just read the WKe-Book independently, see Fig. 2). We assessed students' skills prior to the immediate treatment (pre-test), after the immediate treatment (mid-test), and again after the delayed treatment classrooms completed the WKe-Book (post-test). In this way, all students and teachers participated in the WKe-Book program by the end of the study. For the RCT, we compared students' scores after the immediate treatment group completed the WKe-Book and before the delayed treatment group started the book at mid-test.

The following research questions guided this study:

1. To what extent is our researcher-developed word knowledge calibration task related to a standardized assessment of reading comprehension?
2. To what extent does reading the WKe-Book, with or without book club, impact word knowledge calibration compared to the delayed treatment control group?
3. To what extent does reading the WKe-Book, with or without a book club, build students' strategy use and word knowledge compared to the delayed treatment control group?
4. To what extent do increases in students' metacognition (i.e., word knowledge calibration, strategy use and word knowledge), as a result of reading the WKe-Book, predict reading comprehension and vocabulary?

2. Methods

2.1. Participants

The participants for this study, third through fifth grade students, were recruited from two elementary schools in the same district in South Central Arizona in the United States. With the approval from the principals in these schools, all third, fourth, and fifth grade teachers were invited to attend an informational meeting about the current study at the beginning of the school year. All but one teacher agreed to participate, and no teacher left the study. Classrooms were randomly assigned after rosters were available and

ranked using the class mean of school administered reading assessments. Using this ranking, we created matched classroom pairs within grade and school and randomly assigned one member of the classroom pair to the immediate treatment with the other assigned to delayed treatment control group.

Students (N = 603) were from 9 third grade, 7 fourth grade, and 9 fifth grade classrooms. Forty-nine percent were girls. The majority of the students were Hispanic (67%), 10% were Caucasian, and 9% were African American. In Arizona, all instruction in public schools is conducted in English and this was the case for these two schools. All testing was also conducted in English.

Approximately 70% of the students qualified for the U.S. National School Lunch Program (NSLP). The mean age at the start of the study was 9.5 years old and ranged from 8 years, 4 months of age up to 10 years, 2 months of age. Both schools were Title-1 schools and served students with characteristics that mirrored our sample. School A was 78% Hispanic, 10% African American, and 6% Caucasian; 52% male; 79% of students participated in the National School Lunch Program (NSLP); School B was 74% Hispanic, 11% African American, and 10% Caucasian; 50% male; 71% participated in NSLP. Of the 391 students in the immediate treatment group, 191 were randomly assigned to participate in the book club; and of the 212 students in delayed treatment control group, 103 were in a book club group.

2.2. Procedures

2.2.1. The WKe-Book, The Dragon's lair: the story of the Scarlett Square

Written by a professional children's book author, the WKe-Book titled *The Dragon's Lair: The Story of the Scarlett Square* (McDonald, 2012) tells the story of a young boy (who the student names) and his magic unicorn, Finn, who go on adventures by selecting a colored square on a counterpane quilt (see Appendix B for screenshots). There are two main characters, the boy and a girl (who the student names) in all of the story streams. In the Dragon's Lair, the boy is taken to a village where the evil green dragons are kidnapping children and taking them into the caves to work for them. The boy meets the girl in the town during a green dragon raid. In the original story, the two go together and have a series of adventures where they find the caves, save the Ryan twins, meet the good red dragons, and work with them to defeat the green dragons and secure the magic eagle and emerald. Six chapters long, there are decision points and one comprehension question for each chapter with 14 different story streams (see Fig. 1).

Target vocabulary words were selected using the Academic Word List (Coxhead, 2000), the SAT/ACT Word List (http://quizlet.com/1022309/college-board-top-100-common-satact-vocabulary-words-flash-cards/), Spanish cognates, and what we call the "coolness" factor, which was based on interviews with third to fifth grade students during the development study (2012–2013). Access to the WKe-Book is available upon request from the first author.

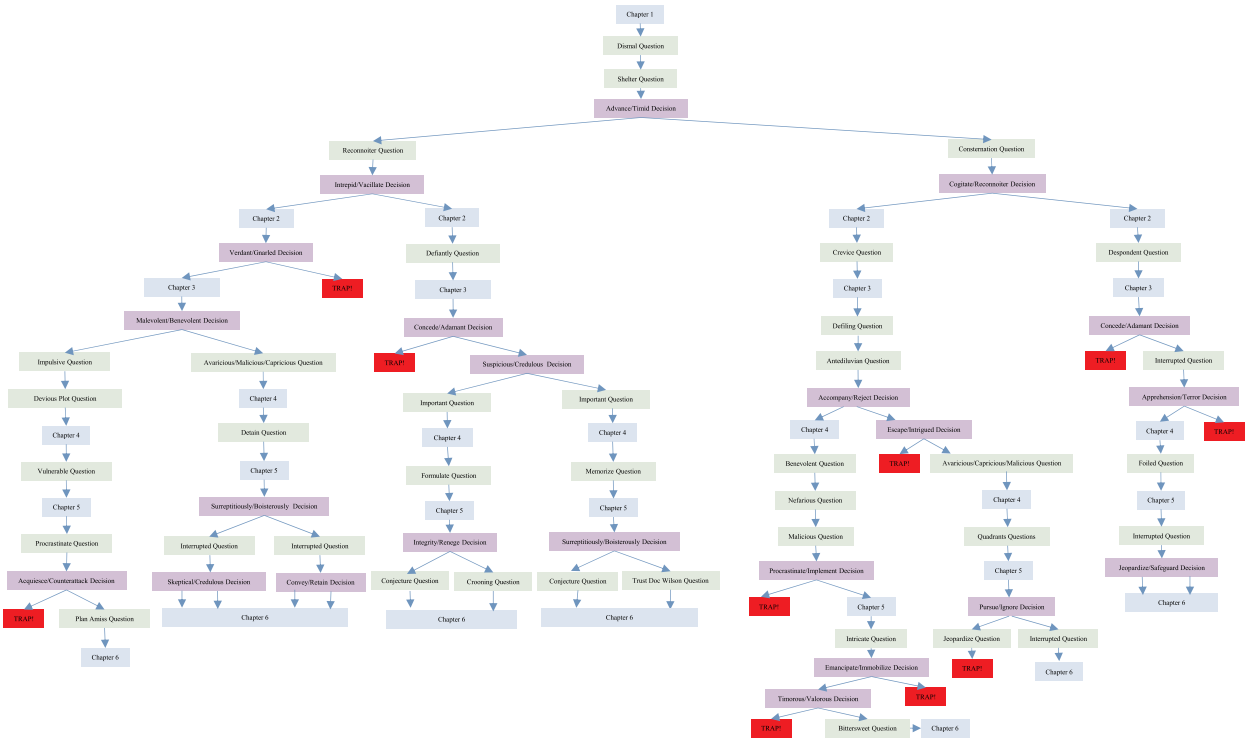

Fig. 1. Schematic of the WKe-Book. Green boxes represent comprehension questions, blue represent new chapters, purple represent decision points, and red represent bad decision points. PDF is available upon request from the corresponding author. (For interpretation of the references to color in this figure legend, the reader is referred to the Web version of this article.)

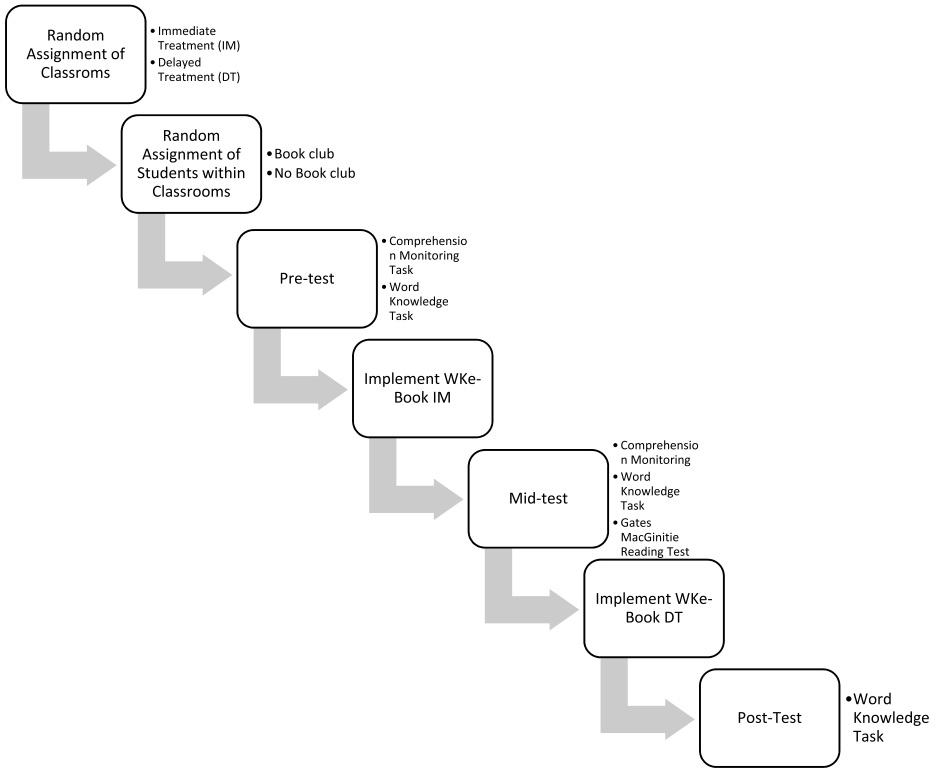

Fig. 2. Research design for the WKe-Book cluster randomized controlled trial where randomized controlled trial (RCT) treatment effects of the WKe-Book are tested at Mid-test.

2.2.2. Design implementation

Due to limited resources with both research staff and materials, including class sets of iPads, third and fourth grade classes first received the WKe-Book in the fall of 2014, and fifth grade classes participated in the study in the early spring of 2015. The WKe-Book intervention was three weeks long, with an additional 3–4 weeks of testing including the pre-test, mid-test, and post-test. Within each classroom, students were randomly assigned to one of two treatment conditions: WKe-Book with book club or WKe-Book with no book club. This allowed us to test the effectiveness of the book clubs versus just reading the WKe-Book on its own in addition to testing the use of WKe-Book versus delayed treatment control condition.

The book club sessions consisted of students working with research teachers in small groups. Research teachers were trained research assistants who were also certified teachers. They were in the classrooms three days a week for at least 30 min. We worked with the classroom teachers to find a time that worked best for them, with most choosing to include the WKe-Book during their dedicated language arts block of instruction. In the WKe-Book no book club condition, students were instructed to read the WKe-Book individually on the iPad, which we provided, for the 30-min period. Regardless of the treatment condition (i.e., book club or no book club), all students received the same introduction to the WKe-Book, which was delivered to the whole class on the first day of the intervention. During the first week, research teachers described what the WKe-Book was, and how to use the iPads, including accessing features such as logging in and using the dictionary function on the iPad. During the WKe-Book sessions, classroom teachers supported the students who were reading the WKe-Book to ensure that they remained on-task while the research teachers conducted book clubs. During the last week of the WKe-Book sessions, we asked the teachers to sit in on at least one book club meeting, but teachers were not expected to lead any book club meetings.

Approximately 15 students per class were assigned to the WKe-Book with book club condition and the remaining students were in the no book club condition ($n = 15$, total class enrollment mean was about 30). There were three book club groups per class, and each group consisted of approximately five to six students. Research teachers met with one group per day for 15 min. In other words, students in the book club condition spent two days a week just reading the WKe-Book on their own and one day a week meeting with their book club. Students in the no book club control condition spent all three days a week reading the WKe-Book. If students completed the WKe-Book before the three weeks were over, they were encouraged to read the story again and to choose different paths to see how the story might change.

In the book club condition, the following target reading strategies were explicitly taught to students: context clues, word history/structure, and using the dictionary. Students were taught that these were specific tools that they should use when they encountered an unfamiliar word. For *Context Clues*, students were encouraged to read other parts of the text and try to infer the meaning of the word. Students were also taught to consider *Word History/Structure* and how to analyze word parts to figure out the word meaning.

Specific word parts that were introduced were common suffixes and prefixes, along with common roots and word history. *Using the dictionary* taught students how to use the iPad dictionary and how to interpret the definitions when they encountered a word that they did not know. Written materials were also given to students during book club meetings that focused on specific target reading strategies offline with teacher support. For example, one paper-based lesson on using the dictionary included the materials where the students were provided a formal definition of a target word and asked to write answers to questions such as "What does benevolent mean?" or "The opposite of or antonym for *benevolent* is (mean, funny, strong)." See Appendix C for a sample lesson plan.

Delayed treatment control classrooms were randomly observed to see what activities they were doing during the time the treatment classrooms were participating in the study. In one fifth grade classroom, for example, students were taking a quiz on a story they had just finished reading. In another classroom, students were given a packet of short passages to read in which they were instructed to underline the important details in each passage and then answer a set of questions about the passages.

2.3. Measures

2.3.1. Comprehension monitoring task

This task was designed to assess students' word knowledge calibration and the specific learning strategies targeted in the WKe-Book using unfamiliar words. Administered to the entire class, there were seven items in this written assessment. Each item included a short paragraph that included a target word (e.g., circumnavigate) that was most likely unfamiliar to third through fifth grade students. The task asked the students to circle the words they did not know in the paragraph. Students then read and answered the following questions: (a) What would be a good title for this paragraph? (This is designed to assess students' summarization skills); (b) Do you know what circumnavigate means? Circle one: *yes, kind of, no*; (c) What do you think circumnavigate means? (Children write out the definition of the target word); and (d) How did you figure out what the word means? (This is designed to assess word learning strategies and intentional use of other strategies).

For the first question, choosing a title for the paragraph, the scores ranged from 0 to 2. Responses that were not relevant to the theme of the paragraph were given 0 points; responses that partially tapped but did not fully address the main idea of the paragraph were given 1 point; responses that addressed the main idea fully were given 2 points. The second question asked students to judge to what extent they knew the meaning of the target word—Do you know what _ means? They then circled either yes, kind of, or no. The third question required children to write out the definition of the target word and were given a score of 0–2 points. Definitions that were not related at all to the target word were given 0 points; definitions that were related to the target word but were not close to the specific meaning of the word were given 1 point; definitions that closely matched the actual meaning of the word were given 2 points. The final question was designed to assess students' ability to report word learning strategies and intentional use of other strategies. One point was given if students named at least one of the word learning strategies, and no point was given if they did not give any answer or did not name any strategy. Overall, reliability was acceptable with alpha equal to 0.81 at mid-test. Alpha improved to 0.87 when pre-, mid-, and post-test administrations were considered together.

To assess word knowledge calibration, we compared students' self-reports of whether they knew the target word (yes, kind of, no) representing their judgement of how well they knew the meaning of the target word, with how accurately they defined the word (see Table 1). This enabled us to create five variables representing different aspects of calibration (Bol & Hacker, 2012): children who reported they knew the word and they did (Knows Knows), children who reported they kind of knew the word and partially defined it (Knows Kind of Knows), children who reported they didn't know the word and were unable to define it (Knows Doesn't Know), children who overestimated their knowledge reporting they knew the word when they did not (Overestimate), and children who underestimated their knowledge reporting they did not know the word but then defined it correctly (Underestimate).

2.3.2. Word knowledge task

This task was designed specifically to assess students' knowledge of the target words that were introduced in the WKe-Book. However, because the students read different story streams, not all children were exposed to the specific target words on this assessment. The task is divided into three subtests: Matching, What's the Meaning of This?, and Let's Figure It Out.

In the *Matching* subtest, the students match target words with the corresponding definition from three choices (e.g., dilemma: a problem, predicament, or quandary). There were 10 target words in the Matching subtest. Each item was scored as correct (1 point) if

Table 1
Word knowledge calibration coding scheme for the comprehension monitoring task.

	I know the meaning	I kind of know the meaning	I don't know the meaning
Accurately defines the word	**Knows that he/she knows the word and can define it**		Underestimates whether he/she knows the meaning of the word
Partially defines the word		**Knows that he/she kind of knows the word and partially defines it**	
Not able to define the word	Overestimates whether he/she knows the meaning of the word		**Knows that he/she doesn't know the meaning of the word and cannot define it**

Note. Across the top are the students' judgements of how well they know what the target word means. Along the side are how accurately they were able to define the target word. The diagonal variables (bold) represent strong word knowledge calibration.

the student matched the appropriate definition with the target word. No point was given if students did not match the target word with the right definition. Students could receive up to 10 points on this subtest.

In the *What's the Meaning of This?* subtest, the students read a sentence that includes a target word and choose the synonym from a bank of three words (e.g., The test was very hard. Jill had to cogitate about many of the answers; a. cry, b. think, c. laugh). There were 10 items in this subtest, and each item was worth 1 point. These items were scored as correct only if students chose the correct synonym for the target word. Students could get up to 10 points on this subtest.

In the *Let's Figure It Out* subtest, the students read a sentence and are asked to write the definition of the underlined target word (e.g., The puppies were so boisterous they were licking and crawling all over the babies.). Each question in this subtest was worth up to three points. Zero points were given if the definition was not related to the target word; one point was given if students wrote a one-word definition that was relevant to the broader meaning of the target word; two points were given if the definition was close to the dictionary definition of the target word but not complete; three points were given if the definition was precise and complete as might be written in dictionary. There were five items in this subtest, and students could get up to 15 points.

To do well on the Word Knowledge Task thus required more than just naming pictures, as with many vocabulary assessments. Rather, our aim was to design an assessment that would require use of word learning strategies to understand word meanings. As such, this assessment was designed to have a strong metacognitive component.

Trained research assistants who were blind to the study condition scored the task. They held regular meetings to discuss and practice scoring of the *Let's Figure It Out* subtest. Once sufficient consensus was met, two coders scored all five items in this subtest independently. They compared their scores to each other, and the agreement between them was 97%. Once they were reliable, each test was scored by one coder and verified by another.

In the analyses, the raw scores for each of the word knowledge task subtests, Matching, What's the Meaning of This?, and Let's Figure It Out were totaled (28 items), with a maximum possible of 35 points. Item reliability at the mid-test was acceptable with alpha equal to 0.79. When considered at the subtest level across all time points (pre-, mid-, and post-test), reliability improved (alpha = 0.89).

2.3.3. Standardized reading comprehension and vocabulary assessment

The *Gates-MacGinitie Reading Test* (MacGinitie, MacGinitie, Maria, & Dreyer, 2002) was given to assess students' reading vocabulary and comprehension skills. For the reading vocabulary task, students were provided with a word in a short phrase and were shown four possible definitions. They were required to select the best answer. In the reading comprehension task, students read paragraphs and answered questions that varied in inferencing levels. In all grades, the Gates-MacGinitie assessment was given during the mid-testing. For analyses, we used the extended scale scores (ESS) with a mean of 500 and a standard deviation of 15. The published reliability for this test is 0.96.

2.4. Fidelity of implementation

2.4.1. Classroom implementation

To ensure fidelity of implementation, all classrooms and research teachers were observed by the project director and a research assistant who did not work closely on the WKe-Book project. Each classroom was observed once toward the middle of the study by both observers. A checklist was completed by each observer for every research teacher. The checklist included the following: (1) were students generally engaged while reading the WKe-Book? (2) during the book club, did the research teacher (a) discuss target comprehension repair strategies including context clues, word history/structure, and using the dictionary; (b) have the students in the book club do story retell; (c) did each student retell what he/she read previously, how stories may differ, what might have happened if students chose a different path, and did students discuss the meaning of target words?; (d) did the research teacher individualize instruction during book club?; (e) during book club, did the research teacher activate students' prior knowledge (e.g., Have you ever had to cogitate before making a decision?) and ask reasoning questions (e.g., Why did XX happen?); (f) direct students to use context clues (e.g., How does the author show that the green dragons are mean?), and (g) make predictions about what might happen next?

Both observers noted that the no book club control students read the WKe-book independently while research teachers led book clubs. The classroom teachers generally helped students who were reading the WKe-Book on the iPads. Some students needed support logging into the WKe-Book, for instance. Observers reported that during book club, the research teachers discussed at least one target reading strategy; asked students to each do a story retell; and included at least one of the listed strategies.

2.4.2. Student user-logs

The WKe-Book tracked how the students read the book and their patterns of use and responses while reading: (1) time spent on each page (minutes and seconds); (2) words read per minute on selected pages (i.e., fluency); (3) WKe-Book resources used (e.g., iPad dictionary); (4) responses to reading comprehension questions posed to students throughout the book as correct or incorrect; (5) the decisions they made and story streams selected by each student; (6) number of times students read the WKe-Book; (7) click actions, for example, answering questions; and (8) sequential patterns of use (i.e., the order in which students read the WKe-Book pages). We used the logs to group students based on where they were in the stories for the students in the book club condition.

These data were also used to monitor student fidelity, including how much time students spent reading the WKe-Book. Examination of the student user logs using hierarchical linear modeling (HLM, Raudenbush, Bryk, Cheong, Congdon, & du Toit, 2004), with repeated measures over time nested in students, revealed that all students spent the majority of the WKe-Book sessions reading the WKe-Book; on average 22 min/session (384 pages/student at 29.4 s/page, $SD = 26.0$). Students read the WKe-Book for an

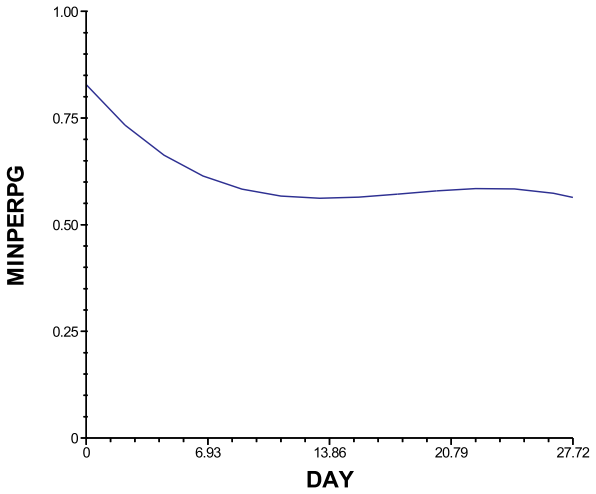

Fig. 3. Growth curve model results from student user logs using multi-level modeling. Time spent reading pages, minutes per page (MINPERPG), over time (days) nested in students.

average of 14.64 days (SD = 6.58), for an average total/student of 3.28 h reading the WKe-Book. Over the course of the three weeks, students generally spent more time per page at the beginning of the WKe-Book sessions (days 1–10, about 45 s/page, on average) but tapered off and remained fairly steady at 30 s/page, for the rest of the WKe-Book sessions (see Fig. 3). Students answered approximately 60% of the comprehension questions correctly, and this remained steady over the course of the three weeks.

3. Results

Results of our descriptive analyses revealed that, on average, students in the study achieved Gates-MacGinitie Reading Comprehension percentile rank scores between the 27th and 35th percentile (the expected mean is at the 50th percentile), which ranged between the 1st and 97th percentile, suggesting wide variability in students' reading comprehension skills (see Table 2). This might be expected given the demographics of the schools and the community. As anticipated, there were no significant differences at baseline between immediate treatment and delayed treatment control groups ($p > 0.05$). For the researcher-designed word knowledge task, students in both groups made significant gains from pre-to mid-to post-intervention, but this varied by condition (see Table 3), and all groups were equivalent at pre-test ($p > 0.05$). No students left the study prior to mid-testing and two children left the study prior to post-testing (attrition = 0.3%). No teacher left the study.

3.1. Research question 1

Our first research question asked to what extent our researcher-developed word knowledge calibration task was related to a standardized assessment of reading comprehension. To answer this question, we used HLM to account for the nested structure of the data; students nested in classrooms. Students' reading comprehension score using extended scale scores (ESS) was the outcome variable. Grade level was entered at the classroom level as a covariate and was centered at the mean for the sample (M = 4.0, SD = 0.87). We used the 5 word knowledge calibration dummy variables described previously, coded as 1 or 0. So, for example, children who reported that they knew the meaning of the word, and then defined it completely and correctly (Knows Knows), were coded 1 and all other students were coded 0. Then each of the five variables were entered as covariates. The fixed reference group was students who did not fall into one of the calibration groups (i.e., no correspondence between judgement and ability to define the word). Results are provided in Fig. 4 and Table 4. Results showed that children who reported they knew a word and then defined it

Table 2
Descriptive statistics on the Gates-MacGinitie reading test percentile ranks (PR).

	N	Minimum	Maximum	Mean PR	Std. Deviation
3rd Grade Reading Comprehension	198	1.0	95.0	34.955	22.533
3rd Grade Total Score	198	1.0	95.0	36.056	22.948
4th Grade Reading Comprehension	193	1.0	93.0	30.580	23.300
4th Grade Total Score	193	1.0	89.0	32.990	22.476
5th Grade Reading Comprehension	212	1.0	95.0	29.401	24.063
5th Grade Total	212	1.0	97.0	27.731	22.569
Total all grades	603				

Table 3
Descriptive statistics for the word knowledge task raw score by group and testing time.

	Immediate Treatment		Delayed Treatment	
Time of testing (n students)	Book Club	No Book Club	Book Club	No Book Club
Pre-Test (603)	10.46 (4.5)	10.01 (4.44)	10.31 (4.58)	10.31 (4.30)
Mid-Test (603)	13.80 (6.06)	12.59 (5.63)	11.73 (4.82)	11.81 (4.48)
Post-Test (601)	13.66 (6.34)	12.93 (5.41)	14.54 (6.04)	13.76 (5.65)

Note. Standard deviations in parentheses. Gains from pre-to mid-test were significant for both groups with gains greater from the WKe-Book students based on repeated measures ANOVA [$F(1,585) = 3569.82$, $p < 0.001$].

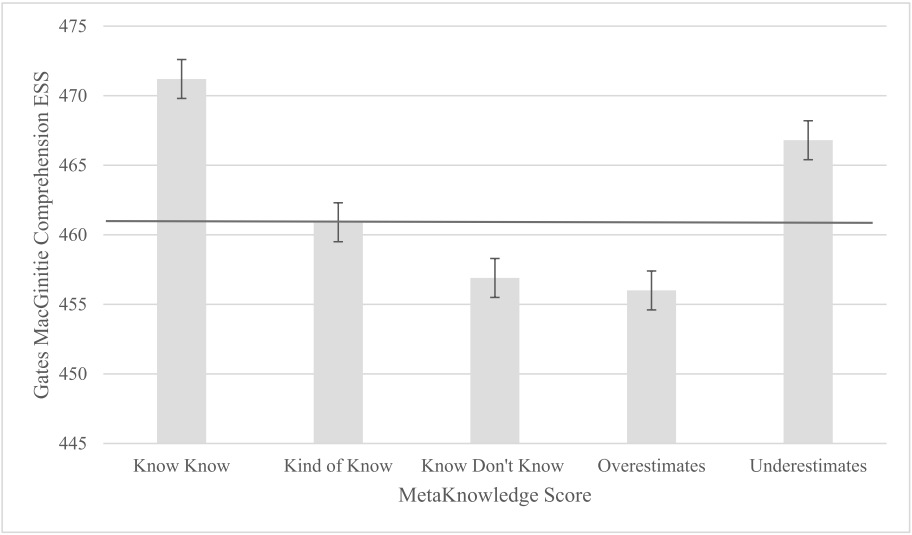

Fig. 4. Word Knowledge Calibration predicting Reading Comprehension (ESS). Fixed reference group mean for reading comprehension (ESS) was 461 (horizontal line). Error bars are standard errors.

Table 4
Effect of word knowledge calibration on reading comprehension.

Fixed Effect	Coefficient	Standard error	*t*-ratio	Approx. *d.f.*	*p*-value
For Intercept, β_0					
Fitted Mean Comprehension, γ_{00}	460.884	1.324	347.895	23	< 0.001
Grade, γ_{01}	9.705	1.933	5.020	23	< 0.001
For slope, β_1					
Knows Knows coefficient, γ_{10}	10.301	1.814	5.678	563	< 0.001
For slope, β_2					
Knows Kind of Knows, γ_{20}	1.945	2.308	0.843	563	0.400
For slope, β_3					
Knows Doesn't Know, γ_{30}	−4.048	0.979	−4.132	563	< 0.001
For slope, β_4					
Underestimates, γ_{40}	−4.883	0.978	−4.991	563	< 0.001
For slope, β_5					
Overestimates, γ_{50}	5.856	1.445	4.051	563	< 0.001

Final estimation of variance components

Random Effect	Standard Deviation	Variance Component	*d.f.*	χ^2	*p*-value
INTRCPT1, u_0	3.988	15.910	23	34.771	0.055
level-1, r	27.487	755.55			

Deviance = 5599.333.
Note. Grade is mean centered at 4th grade. Each variable is coded 1 = name of variable. 0 = all others. For example, Knows Knows = 1, all others = 0. See Fig. 4 for graphical presentation of results.

correctly generally had stronger reading comprehension scores than all other students. Students who underestimated their knowledge of words generally had the next highest scores. Students who reported they kind of knew the word and then only partially defined it scored at the mean of the reference group. Students who reported they did not know the word and were unable to define it correctly and students who overestimated their word knowledge demonstrated the weakest reading comprehension scores.

3.2. Research question 2

Our second research question asked: To what extent does the WKe-Book with or without a book club impact students' word knowledge calibration compared to the delayed treatment control group? Results are presented in Fig. 5 top and Table 5. Again, grade level was centered at the mean for the sample. The WKe-Book treatment variable (1 = immediate treatment group; 0 = delayed treatment control classroom) was entered at the classroom level; the Book Club variable (1 = book club; 0 = no book club control student) was entered at the student level because for the respective variables, that was the level of random assignment.

Results reveal that there was a significant effect of treatment but only for students who participated in the weekly book club. There was no significant effect of treatment on whether children reported they kind of knew the word and then partially defined it. Students in the WKe-Book condition (immediate treatment) were more likely to report they did not know the word when they did not define it correctly (knew they didn't know the word, see Fig. 5 bottom) than students in the delayed treatment control group. There was no significant effect of the WKe-Book on either overestimating or underestimating knowledge; although fifth graders were less

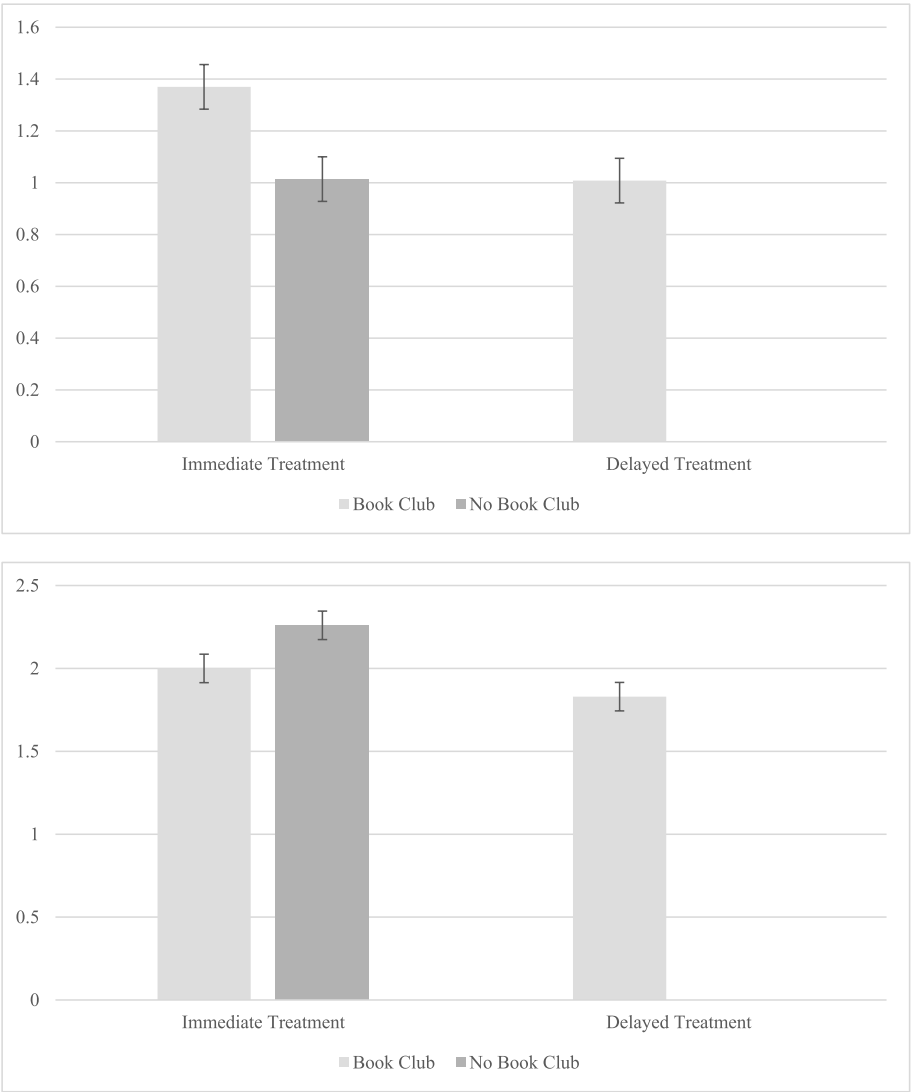

Fig. 5. *(top).* Effect of WKe-Book with and without the weekly book club on word knowledge calibration, specifically, for children who report they know the word and then define it correctly. Fig. 5 *(bottom)* Effect of WKe-Book with and without book club compared to delayed control group for students who reported they did not know the word and did not define it correctly. Error bars are standard errors.

Table 5
WKe-Book Predicting Word Knowledge Calibration Where Students Report They Know They Know the Word and Define it Correctly (Knows Know).

Final estimation of fixed effects (with robust standard errors)					
Fixed Effect	Coefficient	Standard error	*t*-ratio	Approx. *d.f.*	*p*-value
For INTRCPT1, β_0					
Fitted mean, γ_{00}	1.009	0.086	11.633	22	< 0.001
Grade, γ_{01}	0.501	0.067	7.481	22	< 0.001
WKe-Book Immediate Treatment, γ_{02}	0.006	0.125	0.050	22	0.961
For Book club slope, β_1					
Book Club, γ_{10}	0.024	0.110	0.220	571	0.826
WKe-Book X Book club, γ_{11}	0.339	0.157	2.154	571	0.032

Final estimation of variance components					
Random Effect	Standard Deviation	Variance Component	*d.f.*	χ^2	*p*-value
INTRCPT1, u_0	0.19590	0.03837	22	40.87804	0.009
level-1, r	1.03329	1.06769			

Deviance = 1759.309026.
Note. WKe-Book Immediate Treatment = 1, delayed treatment control = 0; Book club = 1, no book club control = 0. WKe-Book X Book club = 1 for children in immediate treatment who participated in book club, all others = 0. See also Fig. 5.

likely to overestimate knowledge than third graders (coefficient = −0.21), and were more likely to underestimate their knowledge (coefficient = 0.112).

3.3. Research question 3

The third research question asked: To what extent does the WKe-Book with or without the book club build students' strategy use and word knowledge compared to the control group? At mid-test, students in the WKe-Book immediate treatment classrooms were more likely to report that they used the specific strategies targeted in the WKe-Book (e.g., dictionary use and context clues) to figure out the word, compared to students in the delayed treatment control group (see Fig. 6 and Table 6). However, this was only the case for students in the book club condition (d = 0.58). In the no book club condition, students did no better than students in the delayed treatment control group.

There was a significant positive treatment effect of the WKe-Book on the word knowledge task at mid-testing. Additionally, because the word knowledge task was given at post-test, we were able to examine the gains made in word knowledge by the delayed treatment control group, and the extent to which students in the immediate treatment group retained their learned word knowledge. Thus, we ran three HLM models; one each for the pre-, mid-, and post-tests (see Fig. 7 and Table 7) with grade centered at the mean for the sample and controlling for pre-test scores, when mid- or post-test was the outcome. The mid-test outcome was the primary analysis for the RCT.

We found that students in the immediate treatment group made significantly greater gains in word knowledge compared to the delayed treatment control group students and the effect was about twice the size for students who participated in the book club

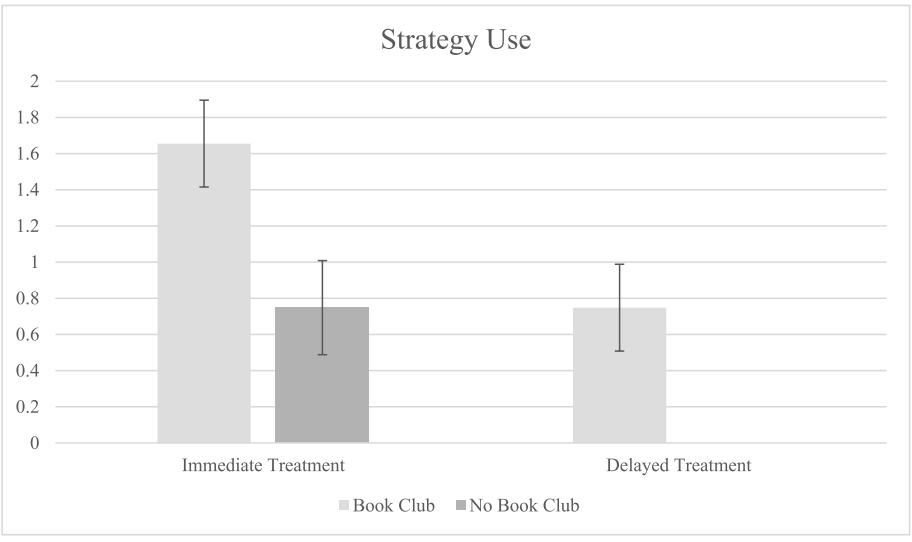

Fig. 6. Effect of WKe-Book with and without book club on Strategy Use to figure out unknown words. Error bars are standard errors.

Table 6
WKe-book predicting report of strategy use comparing treatment (WKB-IM = 1) and control (= 0) and book club (= 1) vs No book club (= 0).

Final estimation of fixed effects (with robust standard errors)					
Fixed Effect	Coefficient	Standard error	*t*-ratio	Approx. *d.f.*	*p*-value
For INTRCPT1, β_0					
INTRCPT2, γ_{00}	0.749	0.152	4.904	22	< 0.001
GRADE, γ_{01}	0.191	0.123	1.556	22	0.134
WKe-Book Immediate Treatment, γ_{02}	−0.086	0.183	−0.470	22	0.643
For BOOK CLUB slope, β_1					
INTRCPT2, γ_{10}	−0.105	0.115	−0.903	569	0.367
WKe-Book Immediate Treatment, γ_{11}	0.915	0.225	4.062	569	< 0.001

Final estimation of variance components					
Random Effect	Standard Deviation	Variance Component	*d.f.*	χ^2	*p*-value
INTRCPT1, u_0	0.378	0.143	22	54.076	< 0.001
level-1, r	1.514	2.292			

Statistics for current covariance components model.
Deviance = 2211.461137.
Note. WKe-Book Immediate Treatment = 1, delayed treatment control = 0. See also Fig. 6.

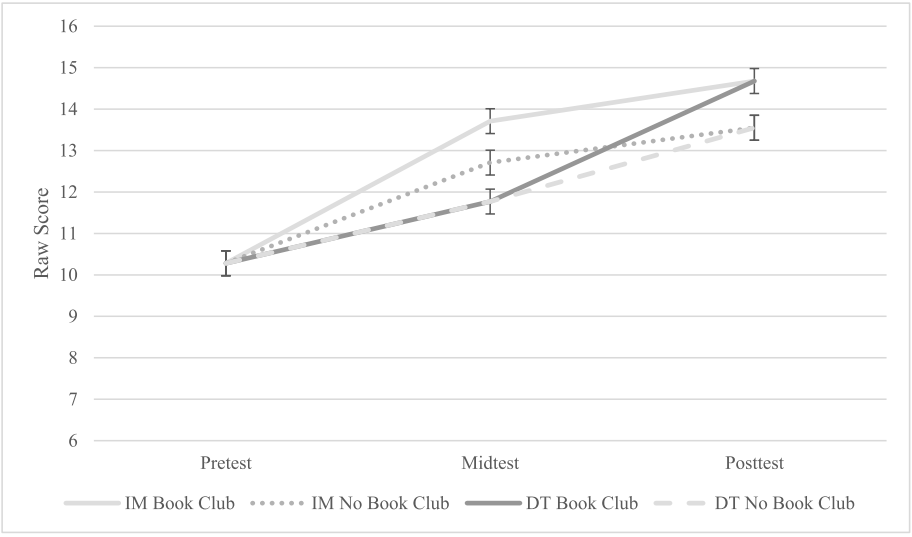

Fig. 7. Effect of WKe-Book, with and without Book Club, on Word Knowledge score at Pre- Mid- and Post-Test for the Immediate Treatment students who participated in a Book Club (IM Book Club), for students who were in the Immediate Treatment classrooms who did not participate in Book Club (IM No Book Club), students in the delayed treatment control classrooms who participated in Book Club (DT Book Club) and students in the delayed treatment control classrooms who did not participate in Book Club (DT No Book Club); and Error bars are standard errors.

compared to students in the no book club control. Effect sizes (*d*) were 0.28 for the WKe-Book with no book club and 0.59 for the WKe-Book with the book club. At post-test, students in the immediate treatment group slightly increased their gains and the students in the delayed treatment control made significant gains so that there was no difference between the immediate and delayed treatment group students at post-test once both groups had read the WKe-Book. There continued to be an advantage for participating in the book club with an effect (*d*) of 0.30 at post-tests. Students' grade predicted word knowledge scores at all three time points, with fifth graders generally outperforming fourth and third graders, and fourth graders outperforming third graders. There was about a 1-point difference by grade at the mid- and post-tests.

3.4. Research question 4

Our final research question was designed to test part of the lattice model and asked, to what extent do increases in students' metacognition (i.e., word knowledge calibration, strategy use, and word knowledge), as a result of participating in the WKe-Book with book club, predict reading comprehension and vocabulary? If the lattice model is supported, then gains in metacognition (a cognitive process), as a result of the WKe-Book and book club, should predict reading comprehension and vocabulary (a linguistic process). Using structural equation modeling (Hoyle, 1995), we tested the model in Fig. 8. We created a latent model of the three researcher-designed measures to create a variable called metacognition. Grade had a significant effect (d = 0.57), where students in

Table 7
Effect of WKe-Book on Word Knowledge Task (raw score) at Pre- (top), Mid- (middle) and Post Testing (bottom).

Final estimation of fixed effects at Pre-test (with robust standard errors)

Fixed Effect	Coefficient	Standard error	*t*-ratio	Approx. *d.f.*	*p*-value
For INTRCPT1, β_0					
INTRCPT2, γ_{00}	10.286	0.212	48.511	22	< 0.001
GRADE, γ_{01}	2.918	0.242	12.048	22	< 0.001
WKe-Book Immediate Treatment, γ_{02}	−0.279	0.399	−0.699	22	0.492
For BOOKCLUB slope, β_1					
INTRCPT2, γ_{10}	0.276	0.445	0.621	576	0.535
WKe-Book Immediate Treatment, γ_{11}	0.102	0.508	0.201	576	0.841

Final estimation of variance components

Random Effect	Standard Deviation	Variance Component	*d.f.*	χ^2	*p*-value
INTRCPT1, u_0	0.676	0.457	22	39.606	0.012
level-1, r	3.696	13.664			

Deviance = 3299.592889.

Final estimation of fixed effects at Mid-test (with robust standard errors)

Fixed Effect	Coefficient	Standard error	*t*-ratio	Approx. *d.f.*	*p*-value
For INTRCPT1, β_0					
INTRCPT2, γ_{00}	11.773	0.308	38.211	22	< 0.001
GRADE, γ_{01}	1.072	0.352	3.038	22	0.006
WKe-Book Immediate Treatment, γ_{02}	0.945	0.527	1.790	22	0.087
For BOOKCLUB slope, β_1					
INTRCPT2, γ_{10}	−0.029	0.368	−0.080	558	0.936
WKe-Book Immediate Treatment, γ_{11}	1.009	0.477	2.115	558	0.035
For Pre-WKTOTAL slope, β_2					
INTRCPT2, γ_{20}	0.809	0.041	19.303	558	< 0.001

Final estimation of variance components

Random Effect	Standard Deviation	Variance Component	*d.f.*	χ^2	*p*-value
INTRCPT1, u_0	1.348	1.817	22	112.187	< 0.001
level-1, r	3.298	10.877			

Deviance = 3099.857907.

Final estimation of fixed effects at Post-test (with robust standard errors)

Fixed Effect	Coefficient	Standard error	*t*-ratio	Approx. *d.f.*	*p*-value
For INTRCPT1, β_0					
INTRCPT2, γ_{00}	13.557	0.797	16.993	22	< 0.001
GRADE141, γ_{01}	1.145	0.340	3.362	22	0.003
WKB-IM, γ_{02}	−0.498	0.833	−0.599	22	0.556
For Book club slope, β_1					
INTRCPT2, γ_{10}	1.128	0.589	1.912	556	0.056
WKB-IM, γ_{11}	−0.655	0.635	−1.032	556	0.303
For Pre-WKTOTAL slope, β_2					
INTRCPT2, γ_{20}	0.835	0.051	16.162	556	< 0.001

Final estimation of variance components

Random Effect	Standard Deviation	Variance Component	*d.f.*	χ^2	*p*-value
INTRCPT1, u_0	1.535	2.357	22	109.628	< 0.001
level-1, r	3.706	13.736			

Deviance = 3224.682594.

Note. WKB-IM is coded 1 = immediate treatment classroom, 0 = delayed treatment control class room. Book club is coded 1 = participated; 0 = did not participate in book club. Pre-WKTOTAL is the pre-test raw score on the Word Knowledge Task. See Fig. 7 for graphical presentation of the results.

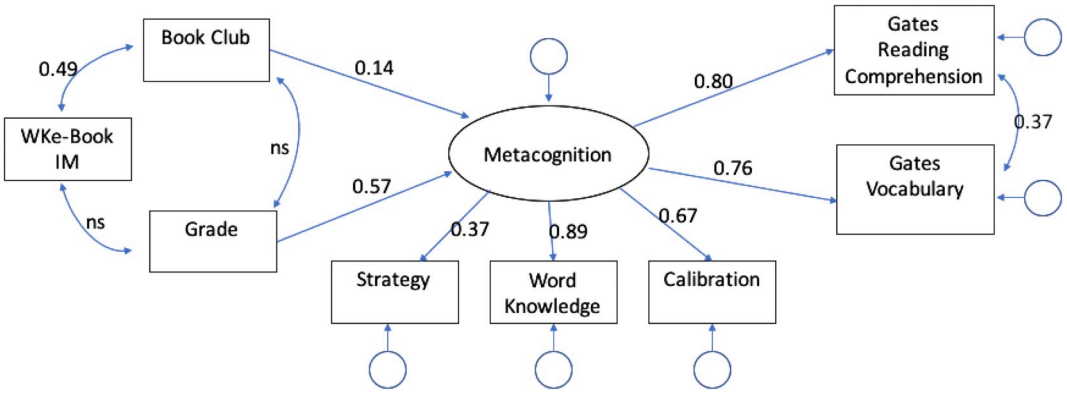

Fig. 8. Structural equation model testing the effect of the WKe-Book, Book Club, and grade on Metacognition, and the effect of Metacognition on Reading Comprehension and Vocabulary. Path coefficients are standardized. All effects, except the very low correlations (ns), are significantly different from 0 ($p < 0.05$). The path from the WKe-Book immediate treatment variable (WKe-Book IM) to Metacognition was not significantly greater than zero and was trimmed from the model to preserve parsimony.

fifth grade generally had stronger metacognition skills than students in fourth grade, who had stronger metacognition than students in third grade. Participating in WKe-Book with book club had a significant but smaller effect ($d = 0.14$) on the metacognition latent variable. In turn, metacognition had a significant effect on both reading comprehension and vocabulary, and these effects were large, 0.80 and 0.76 respectively. The total direct and indirect effect of WKe-Book with book club on reading vocabulary was 0.11 ($p < 0.001$) and on reading comprehension was 0.10 ($p < 0.001$). Model fit was excellent with RMSEA = 0.067 (p-close = 0.043), CFI = 0.969, and TLI = 0.955.

4. Discussion and conclusions

Improving children's reading for understanding has been more difficult than anticipated. The development and evaluation of the WKe-Book was the direct result of the efforts of the IES-funded Reading for Understanding network (ies.ed.gov/ncer/projects/program.asp?ProgID = 62) and the findings of the network researchers. Importantly, across network and other studies, metacognition and language, particularly word knowledge, consistently emerged as important predictors of reading comprehension—but how to improve these skills was less clear (Connor et al., 2018). The principal aim of developing the WKe-Book was to leverage the power of technology within learning opportunities provided in the classroom, to increase students' metacognition, strategy use, word learning, and persistence for reading even when text was challenging.

Overall, the results of the RCT demonstrated that the WKe-Book was effective in improving students' word knowledge calibration, strategy use, and word knowledge, compared to students in the delayed treatment control classrooms. The treatment effects were educationally meaningful, particularly when children participated in the book club (Hill et al., 2008). Gains in word knowledge effects sizes (d) were 0.59 for the WKe-Book with book club and 0.28 for the WKe-Book with no book club; for strategy use, the effect size was 0.58 with book club; and the effect size for word knowledge calibration was 0.32 for WKe-Book with book club.

There are several possible explanations for these WKe-Book effects. First, the technology, particularly the motivational aspects of the technology affordances—choose-your-own adventure and naming main characters—were used to support student perseverance even though the target words used were intended to be difficult for the students. Evidence from the student user logs support this. Students read the WKe-Book for sustained amounts of time—based on user-logs, students on average read 22 min per day. Plus, they read the book more than one time (on average three times), choosing different story lines.

Additionally, we designed game-like consequences for failing to monitor understanding of the text. Students reported that they really did not like being sent back to re-read—particularly when they had to “re-read the chapter and make a better decision” (e.g., choosing *concede* instead of *adamant* when deciding if they should leave the caves). The more explicit comprehension questions provided immediate feedback on whether students chose the correct answer or not and, again, there were consequences for choosing the wrong answer. Plus, the iPad dictionary was always available, even on the comprehension question pages, thus students could avoid the consequences of an incorrect choice fairly easily. However, they had to use a word learning strategy and metacognition to do so (i.e., if I check for the word meaning before I answer, I will not be sent back a page). Accumulating research shows that such higher-level questioning with explicit feedback supports learning (Meyer et al., 2010). The literature on *desirable difficulties* is also relevant to consider for understanding our findings (Bjork & Bjork, 2014). Children learn better when learning is just challenging enough.

The notable increase in effect size by including a 15-min once-a-week book club with a research teacher demonstrates that blending face-to-face instruction with interactive technology learning opportunities has significant potential to improve student learning. One might argue that the book club socially situates the technology in the classroom thereby optimizing teachers' practice and student learning. Increasingly, we are discovering how technology that is designed to provide learning opportunities that complement and enhance teacher-student interactions is generally more effective in supporting learning than technology alone

(Campuzano, Dynarski, Agodini, & Rall, 2009). For example, during book club, students were observed to be engaged and were excited to report and contrast where they were in their story and discuss how they got there with other students (e.g., "Wait, how did you get to the red dragon? I chose malevolent. Did you choose benevolent?"). Note also that students actively used these high-level words in the story re-tells and when discussing the stories. Book clubs provided time to talk about the stories, use the words from the story, and to receive more explicit instruction in the word learning strategies. Importantly, students retained knowledge of the words over about a six-week span of time from the end of the immediate implementation of the WKe-Book to the end of the delayed implementation of the WKe-Book. Plus, the advantage conferred by the book club was replicated across both cohorts (see Fig. 7).

Supporting our hypothesis, word knowledge calibration predicted reading comprehension but the associations were more complex than expected (see Fig. 4). Participating in the WKe-Book improved precise word knowledge calibration for knowing and not knowing the target words (see Fig. 5). However, students with strong word knowledge calibration *and* strong word knowledge demonstrated stronger comprehension; whereas students with strong calibration *but low* word knowledge demonstrated weaker reading comprehension. As hypothesized, improving calibration without also improving word knowledge did not support stronger comprehension. Dunning et al. (2003) note that students with weak word knowledge are not likely to have strong calibration. Yet, as we show here, having strong calibration alone is likely not enough—knowledge is also important. Indeed, children with stronger word knowledge had stronger comprehension regardless of calibration; children with strong word knowledge and calibration (knew they knew the word), and children who underestimated their word knowledge generally had stronger comprehension skills than other children. Children who reported they kind-of knew the word and partially defined the word did no better than the fixed reference group, for whom there was no correspondence between their estimate of their word knowledge and their demonstration of word knowledge (low calibration). At the same time, calibration was still important—children who underestimated their word knowledge (weaker calibration) exhibited reading comprehension scores that were significantly less than the high calibration group with strong word knowledge but higher than other students. In the same way, overestimation was associated with lower reading comprehension skills compared to other students. Of note, rates of overestimation were generally less for older children likely because metacognition is generally improving developmentally for children during middle childhood (Del Giudice, 2014).

The results of our study provide support for the lattice model (see Fig. 8). Explicitly improving metacognition using the WKe-Book with book club predicted stronger reading comprehension and vocabulary scores. The total effects were small ($d = 0.1$), but considering that the WKe-Book intervention was only a three-week program, the effects are promising. The lattice model suggests that improving multiple domains simultaneously is generally more effective than focusing exclusively on one component skill (e.g., just building vocabulary). The WKe-Book was specifically designed to improve students' word knowledge, word learning strategy use, word knowledge calibration, and comprehension monitoring more generally, while employing motivational affordances to support perseverance reading a difficult text. We conjecture that building metacognition, strategy use, and persistence, while building word knowledge, contributed to gains in comprehension and word knowledge. That is, not only did we teach children new words, we also improved their judgements regarding whether they knew a word or not, gave them strategies to learn new words, empowered them to make decisions throughout the book, from naming characters to directing the plot, and gave them reasons to keep on reading when text became difficult. We could not have done this without the affordances provided by technology (e.g., immediate feedback and non-linear book organization). Our next research project will focus on whether we can use similar features and affordances to improve learning of difficult and non-intuitive science concepts, which also require metacognition.

There are limitations to this study that should be considered when interpreting the results. First, the study was conducted in only two schools, which were higher poverty schools with a high proportion of English–Spanish bilingual children. These results may not generalize to other school populations. For example, our use of Spanish cognates (e.g., verdant/verde) likely supported word knowledge for children who knew Spanish and might not be as effective for non-Spanish-speaking students. Additionally, because this was an efficacy study, research teachers conducted the book clubs and were generally responsible for instruction. The classroom teachers' role was important on many levels, and it may be that having two adults in the classroom facilitated WKe-Book implementation. Effects may not hold at scale when the WKe-Book and book clubs are conducted by only one teacher.

As developers, we have an obligation to rigorously test, in RCTs, whether the technology we develop actually promotes learning. Just as we would not want children to take medicine that has not undergone clinical trials, we should not bring technology into the classroom that has not been tested. This study provides an example of developing a technology that shows promise, and then testing this technology using a rigorous research design that meets the What Works Clearinghouse standards (What Works Clearinghouse).

Perhaps the most important finding is that these third through fifth grade students, who attended a high poverty school, learned *and* retained very difficult words gleaned from the ACT and SAT word lists, keeping in mind that, overall, students were reading at about the 30th percentile. This makes us wonder if we, researchers, developers, and educators, might be underestimating what students at higher poverty schools can learn and do. As tablet computers and inexpensive laptops (e.g., Chromebooks) become increasingly available, thoughtful and well-designed technology can provide meaningful and challenging learning opportunities for students, particularly when integrated with face-to-face instruction.

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Elementary Students' Word Knowledge, Comprehension Monitoring, and Reading Comprehension, grant number R305A170163. Additional funding was provided by the National Institutes of Health, Eunice Kennedy Shriver National Institute for Child and Human Development, grant numbers R21HD062834 and R01HD48539.

Appendix D. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.compedu.2018.09.016.

Appendix A

Summary of Relevant E-book Studies Reviewed that Informed the WKe-Book Design.

Citation	Year	Participants	E-book Affordances	Study Design and Findings
Korat, O., & Shamir, a. (2008). The educational electronic book as a tool for supporting children's emergent literacy in low versus middle SES groups. *Computers and Education*, *50*(1), 110–124. https://doi.org/10.1016/j.compedu.2006.04.002	2008	149 children total, 5–6 years old	Oral reading of text, music, film effects/animations, 12-word dictionary based on vocabulary in the story, hot spots on illustrations or words to promote understand and decoding (syllables emphasized)	Children were randomly assigned to one of four groups. There were three eBook conditions: Read story only, Read with dictionary, or Read and play where each student received 3 e-book sessions. Students in all e-book groups improved. **Children in the e-book affordances groups showed more growth in their emergent literacy levels.** Children with the dictionary feature showed greater growth on word meaning.
Krcmar, M., & Cingel, D. P. (2014). Parent–Child Joint Reading in Traditional and Electronic Formats. *Media Psychology, 17*(3), 262–281. https://doi.org/10.1080/15213269.2013.840243	2014	74 child-parent dyads, children were ~4.5 years old.	**E-book vs. Paper Book**	This study used a 2-condition, within-subject, repeated-measures design: parents and their children were monitored to look at reading interactions and child comprehension on two platforms: traditional books and electronic iPad books. **In the electronic reading condition, parents used more talk about the book format than in the traditional book condition.**
Korat, O., Shamir, a., & Heibal, S. (2013). Expanding the boundaries of shared book reading: E-books and printed books in parent-child reading as support for children's language. *First Language*, *33*(5), 504–523. https://doi.org/10.1177/0142723713503148	2013	90 low SES child-parent dyads total, 3–4 years old.	Oral reading of text with text highlighting, animated illustrations, film clips, hot spots, **select words with dictionary definitions.**	Preschoolers and their mothers were randomly assigned to a group: (1) e-book reading; (2) printed book reading; (3) control. The e-book group had access to two e-book conditions: (1) read story and play; (2) read story with dictionary. Children in both intervention groups showed significant progress in word comprehension and PA.
Korat, O., Levin, I., Atishkin, S., & Turgeman, M. (2013). E-book as facilitator of vocabulary acquisition:	2013	144 middle SES children, 4–6 years old.	Oral reading of text, **select words with dictionary definitions. In the dynamic dictionary** condition the	Students read an e-book. The sample was then randomly divided into four groups: (1) adults' vocabulary support; (2)

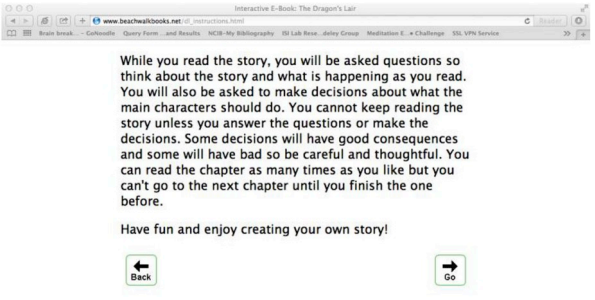
support of adults, dynamic dictionary and static dictionary. *Reading and Writing, 27*(4), 613–629. https://doi.org/10.1007/s11145-013-9474-z			definition was accompanied by an animated depiction of the word.	dynamic visual dictionary support; (3) static visual dictionary support; or (4) no additional support. The findings revealed that adult support appeared to be the most effective form of support. **Dynamic dictionary use was second, static dictionary was third, and no support was least effective.**
Korat, O., & Shamir, A. (2012). Direct and Indirect Teaching: Using E-Books for Supporting Vocabulary, Word Reading, and Story Comprehension for Young Children. Journal of Educational Computing Research, 46(2), 135–152. https://doi.org/10.2190/EC.46.2.b	2012	288 children total, 144 from ages 4–5 and 144 from ages 5–6.5	Oral reading of text with text highlighting, **select words with dictionary definitions and static pictures.**	Children in each age group were randomly assigned to read an e-book or to a control group. The e-book included words whose meaning was supported directly by the software (auditory, visually, and by print) and other words with no such support. The e-book group **significantly improved more than the children from the control group.** Word meanings that were not explained by the software were not learned from the book context alone.
Shamir, A., Korat, O., & Fellah, R. (2012). Promoting vocabulary, phonological awareness and concept about print among children at risk for learning disability: Can e-books help? *Reading and Writing, 25*(1), 45–69. https://doi.org/10.1007/s11145-010-9247-x	2012	110 children total, ages 5–7. All participants had developmental delays.	Oral reading of text with text highlighting, animated illustrations, film clips, hot spots, **select words with dictionary definitions**	The sample was randomly assigned to three groups: activity with the e-book, listening to the book's printed version read by an adult (reading-as-usual) and a control group. Results indicated that the children **exposed to the e-book displayed significantly higher emergent literacy improvement** (vocabulary and phonological awareness).
Korat, O. (2010). Reading electronic books as a support for vocabulary, story comprehension and word reading in kindergarten and first grade. *Computers and Education, 55*(1), 24–31. https://doi.org/10.1016/j.compedu.2009.11.014	2010	90 children total, 40 from ages 5–6 and 50 from ages 6.5–7.5	Oral reading of text with text highlighting, animated illustrations, film clips, hot spots, **select words with dictionary definitions**	Children within each age group were randomly assigned to two groups: an intervention group which read the e-book and a control group. The intervention group at both age levels showed more growth than the controls, more progress in word meaning and word reading. Kindergarten children showed greater progress in word reading than first graders across treatment groups.
Hwang, W., Liu, Y., Chen, H., Huang, J., & Li, J. (2015). Role of Parents and Annotation Sharing in Children's Learning Behavior and Achievement	2015	31 children total, 11–12 years old	Text and image anchors, voice annotation, a text-to-speech function, and the ability to hear their own and teachers' annotations, dictionary, editing, annotation sharing	Using a one group, pre/post test design, this study looked at the use of annotatable multimedia e-readers for learning English. **The e-book conditions**

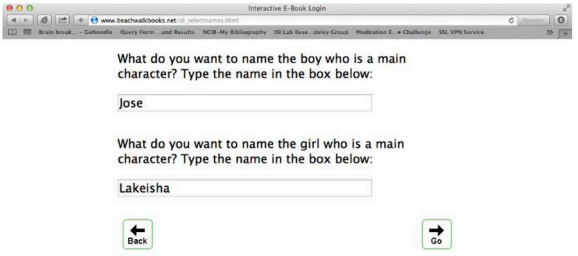
Using E-Readers. *Educational Technology and Society, 18*(1), 292–307.				**reading yielded more discourse initiated by the child and more responsiveness to maternal comments.** Parent-child discussion during printed book reading showed more expanding talk. The educational e-book showed greater growth in word meaning than the commercial e-book.
Liang, T. H., & Huang, Y. M. (2013). An investigation of reading rate patterns and retrieval outcomes of elementary school students with E-books. E*ducational Technology and Society, 17*(1), 218–230.	2013	24 children, grade 6	**Science text presented on tablet. Reading rate tracker.**	This within subjects study involved six reading tasks. Different reading events (e− and printed books) and durations were used to investigate whether there were any differences in related retrieval outcomes. Two reading rate patterns were identified: **Coherent and Fluctuant Readers. The study also found that e-book reading may promote the student's retrieval as compared with reading printed books.**
Leacox, L., & Jackson, C. W. (2012). Spanish Vocabulary-Bridging Technology-Enhanced Instruction for Young English Language Learners' Word learning. *Journal of Early Childhood Literacy, 14*(2), 175–197. https://doi.org/10.1177/1468798412458518	2012	**24 ELL children total, 4–6 years olds**	Preview of target vocabulary words, audio-recorded Spanish vocabulary definitions	A within-subject design that involved repeated readings in control and treatment conditions. The treatment condition involved an e-book with Spanish-bridging vocabulary and adult guidance with multiple vocabulary strategies. More word learning gains were made in the e-book treatment condition than in the control adult reading condition. Significant pre- to post-test differences demonstrated modest growth.
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. https://doi.org/10.1016/j.jecp.2011.12.003	2012	20 children for Study 1 & 27 children for study 2. All ages 4–5.	Animated illustrations, audio of story, **multiple choice questions with feedback,** narrator guide to assist with book usage, hot spots, **no print was visible.**	Two studies focused on vocabulary learning using a pre/post test, within subject design: Study 1 children read eBook stories with and without vocab questions. In Study 2 a different group of children read eBook stories with either hot spots or vocabulary questions. Multiple choice questions were found to increase vocabulary learning and were found to be more effective for learning.
Shamir, A., & Shlafer, I. (2011). E-books effectiveness in promoting	2011	136 children at risk for learning disabilities and	Oral reading of text with text highlighting, animated illustrations, film clips, hot	This study reported the effect of an educational e-book on improvements in Phonological

		phonological awareness and concept about print: A comparison between children at risk for learning disabilities and typically developing kindergarteners. *Computers and Education, 57*(3), 1989–1997. https://doi.org/10.1016/j.compedu.2011.05.001	typically developing children. Ages 5–7.	spots, small games/activities related to the story, **dictionary definitions for select words.**	Awareness and Concept About Print. Students were split into LD and typical groups and then randomly assigned to the eBook condition or a BAU control condition. The findings indicated **improved performance by both experimental groups, but especially LD children in the area of print concepts.**
Verhallen, M. J. a. J., & Bus, A. G. (2010). Low-income immigrant pupils learning vocabulary through digital picture storybooks. *Journal of Educational Psychology*, *102*(1), 54–61. https://doi.org/10.1037/a0017133	2010	92 children unfamiliar with the language of instruction. Age 5.	Story presented on a computer. **Animated illustrations**, oral reading with text, music.	Children were exposed to a digital storybook multiple times. The story was presented with either static or video images. Children in the control condition played with a nonverbal computer game. Children learned words receptively and expressively. **Both treatments benefited vocabulary. Readings with video were especially effective for expressive L2 vocabulary acquisition.**
Jones, T., & Brown, C. (2011). Reading engagement: A Comparison between E-Books and traditional print books in an elementary classroom. *International Journal of Instruction*, *4*(2), 5–22.	2011	22 children in grade 3.	On a laptop: pop-up definitions and pronunciations of words, automatic page turning, and the option of read-aloud narration.	Students completed surveys and reading comprehension tests on three separate reading sessions: one print-based and two e-book titles. **Results showed that format was not as important as students' identification with setting, characters, and theme of the book.** Students indicated a preference for e-books when given the option of a wide selection of titles and the freedom to choose their own e-book.

Appendix B. Screen Shots from the WKe-Book

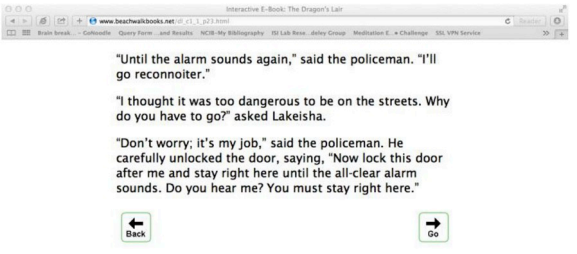
Screenshots of the Dragon's Lair

Screenshot	Description
	*Dragon's Lair* has six chapters. Students are provided explicit instruction about the expectations for comprehension while reading the book. The students use the arrows at the bottom of the page to advance from one page to the next so reading is self-paced.

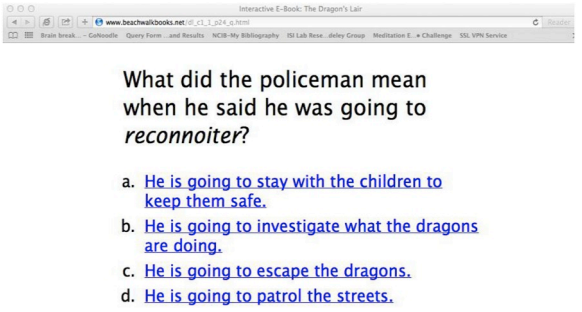


Students name the main characters of the story. This is considered a motivational affordance.

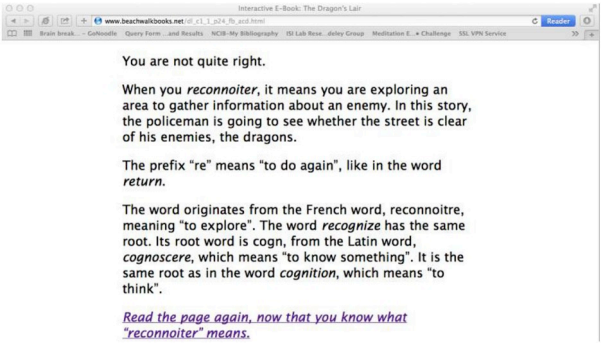
In this page, the main characters meet each other. They are hiding from the dragons in an underground shelter.



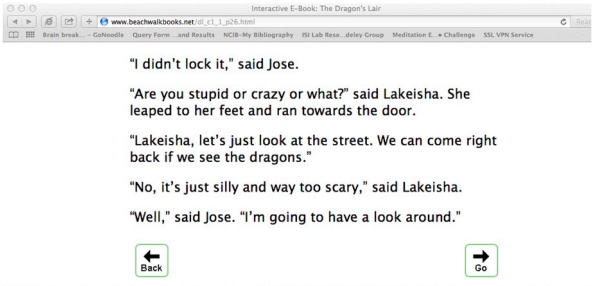
This page continues the previous page and introduces the word "reconnoiter."



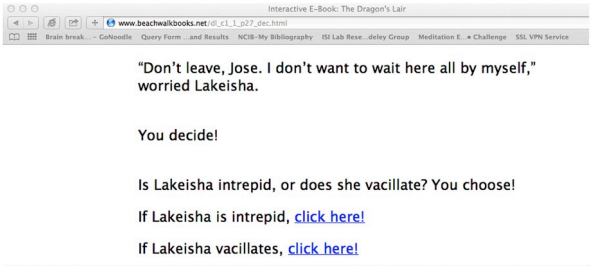
This is an explicit comprehension-monitoring question. There is at least one comprehension-monitoring question per chapter. Students click on the link to respond. They are able to press their finger on "reconnoiter" to access the iPad dictionary. Note that the only way a student can progress is by answering the question.
In this case, the student selected answer A.



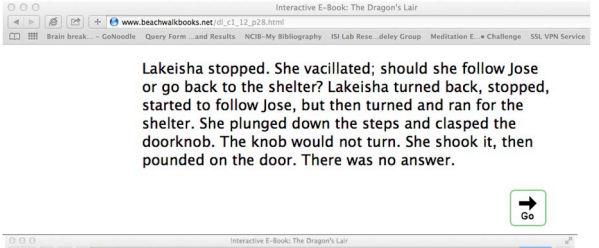
This is the page the student sees after answering the question above incorrectly. Students are provided with explicit feedback and then provided a student-friendly definition, the morphemic structure (i.e., prefix), and the word history. They must then read the previous page again before they are allowed to answer the question again. Table 2 provides an example of a user log. If students select the correct answer, they are still provided with feedback (You are right!), the definition, etc., the link says "Keep reading!" and they continue the story.



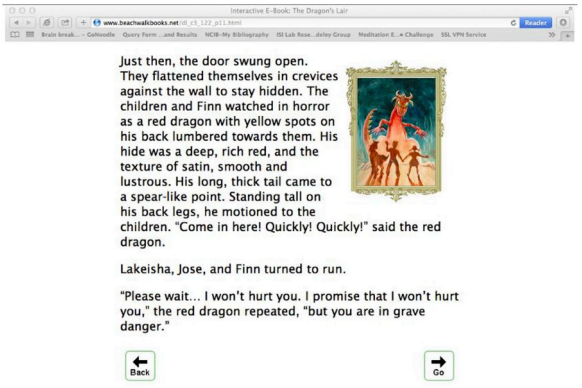
This page is setting up a decision point.



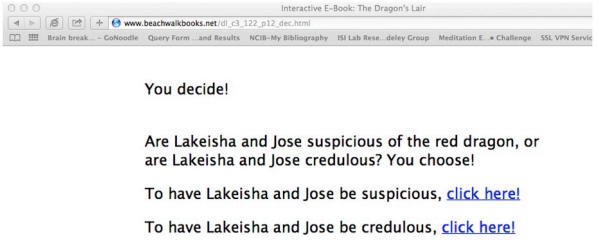
The decision pages present target vocabulary more implicitly. In this case, the story is quite different if Lakeisha is *intrepid* (she goes off with Jose and they have adventures together) or *vacillates*.
Again, students may access the online dictionary before they make a decision.



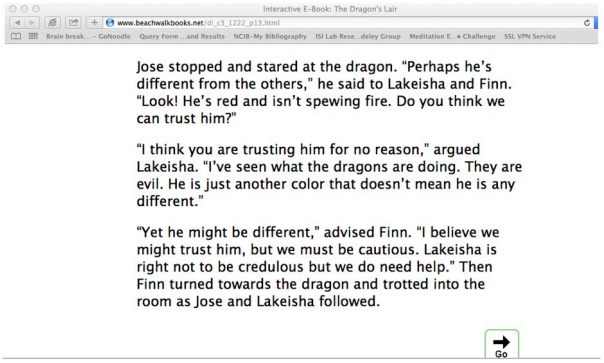
This is the page the students see when they select *vacillate*. The definition is embedded in the narrative text. When students select *vacillate*, Lakeisha is captured by the evil green dragons. The *Dragon's Lair* has 14 different story lines.



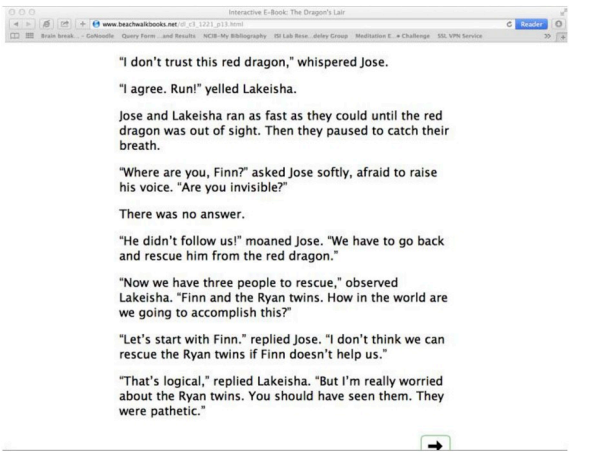
This page precedes a decision (below). There are eight illustrations throughout the story. The intent was to have the students' focus on text rather than pictures. There is no audio component. Students are expected to read rather than listen to text.



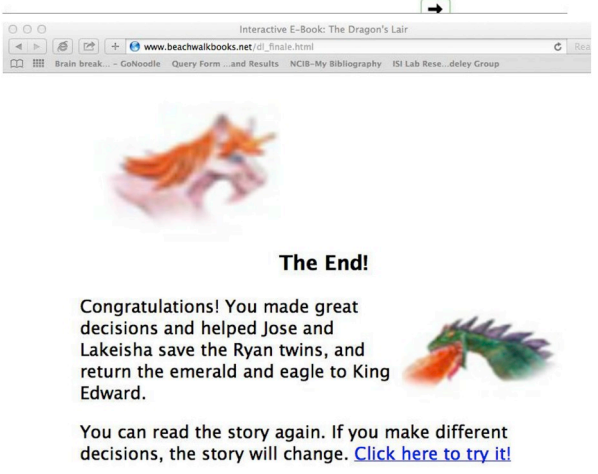
This is another decision page.



This page is next if the students choose *credulous*. Finn is the magic unicorn that takes the main character on an adventure. In this case, the student named the main character Jose.



This is the page the students read when they choose *suspicious*. This is also one of the pages where the user logs provide the words/minute fluency information.



The final page – students are invited to read the book again, make different decisions, and create a new story.

Appendix C

Sample Book Club Lesson Plan

Chapter 4: The Plan(from advances/intrepid/verdant/red dragon benevolent)

LESSON #	LESSON TOPIC
[C]	Word Learning: WORD HISTORY/COGNATES

Overview. Use the lesson plan script below to guide students through a passage in the WKe-Book and discuss the word learning strategy. This lesson should take approximately 15 min to complete in the Book Club. You should individualize instruction with each group as much as possible based on the prior knowledge and reading abilities of the students in your group.

	TEACHER GUIDE	STUDENT GUIDE
OBJECTIVES	• Review the selected passage from the WKe-Book • Discuss word learning strategy • Facilitate retell of story streams • Individualize instruction by asking specific questions	• Read the selected passage carefully • Articulate the word learning strategy • Participate in retell discussion • Practice using the word learning strategy in groups
WORD HISTORY STRATEGY INSTRUCTION	• Provide a copy of the passage from the book for each student to read during phase I of the lesson plan • After students read the passage, ask them to circle words that they don't understand. • Ask them to articulate what strategy they would use to better understand the passage. *Teacher:* *Remember, if you do not understand a sentence, you may not enjoy the story as well, or remember reading this part when asked questions about it. So, we need to find out what the author is telling us by filling in the gaps. Let's start with what do we know about this passage?* **Accept all relevant answers. Provide support by adding statements such as … *The king mentioned a plan. What do you do with plans? Get them together? Make them?*** The author doesn't tell us what formulate means. Let's break the word down into parts and see if we can figure out the meaning. The prefix 'form' has Latin origins. It means 'shape.' For instance, the Spanish word, 'formar,' means to form or to make.	✓ Students will read the passage, and then circle words that they don't understand ✓ Students will articulate what strategy they would use to better understand the passage
PRACTICE TARGET WORD: FORMULATE	*So, if we put what we know about this word together, we have to shape or to make. What do you think?* *Formulate means to shape, create, develop, draw up or put together. Now go back and read the passage. Does it make sense to you now? Let's review. What does the prefix 'form' mean?* • Shape *Form can also be a suffix!* *What other words have "form" in them?* • Formula • Form • Inform • Misinform • Formation	Students will practice with teacher to form meaning of word using word history clues.
RETELL/CONNECT	a. Each student will retell what they read from the previous week's chapter b. Stimulate discussion about opposing streams from other students and how the streams differ c. Ask students to engage in close textual analysis. Help them to understand what their characters were thinking and why they felt a certain way d. Help them to connect what has happened thus far, along with their prior knowledge, to make logical predictions. e. Ask students to reason. Ask them why certain actions happened and make sure they understand the importance of making good decisions	STUDENTS GIVE VARIOUS ACCOUNTS OF THEIR STORY STREAMS
REVIEW	*What are some of the ways you can use word history clues to discover the meaning of an unknown word?*	• Discuss how students have or can use context clues as they read the WKe-Book • Discuss meanings of various prefixes/ suffixes

RESOURCES/MATERIALS

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"Let's go," said [Jose]. "[Lakeisha], that is a great plan!"
"Wait! The green dragons are quick and crafty. We must formulate our plans carefully," cautioned the King. "First we must consult maps so that you understand how to find the cave. Then we must plan alternative routes in the event that our main plan is foiled. So, you must memorize every twist and turn in the caves. Finally, you must learn the poem and how to say it so that the eagle will recognize my command."

REMINDERS/NOTES

- REMEMBER- EXTEND TALK/BUILDS KNOWLEDGE:
  - o Support group discussion—Take the students' responses and stimulate the discussion. Re-voice or summarize students' responses/ideas
  - o Give students an opportunity to ask questions. Encourage them to ask each other questions.

Facilitate the sharing of ideas and information. Provide an opportunity for the group to extend the discussion ("Who else has thoughts on this?")

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