



LXDRESEARCH
AT CHARLES RIVER MEDIA

BuddyBooks

Research Foundation & Logic Model



Authors:

Marty Schultz

Sofia Jimenez, Ph.D.

Rachel Schechter, Ph.D.

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RESEARCH-BASED DESIGN

LXD Research Recognition for ObjectiveEd



This product has been rigorously evaluated and is hereby acknowledged for meeting the educational impact criteria of the Every Student Succeeds Act (ESSA), warranting a **Level IV** for "Demonstrating a Rationale." This recognition is based on its proven effectiveness in enhancing grade-level learning outcomes.

REVIEWED BY THE LXD RESEARCH EXPERT REVIEW PANEL

Rachel Schechter, Ph.D.
Founder of LXD Research

October 2024

DATE

Educators search for high-quality research and evidence-based interventions to strengthen grant applications, to support comprehensive and targeted schools, or to implement new programming in their schools. Evidence requirements under the Every Student Succeeds Act (ESSA) are designed to ensure that states, districts, and schools can identify programs, practices, products, and policies that work across various populations.

Educational programs document their evidence of design, effectiveness, and impact in order to be eligible for federal funding. While there is no singular authority that determine's a program's tier, the Department of Education's Office of Educational Technology provides standards to assess the varying levels of strength of research for education products.

The categories for ESSA Evidence are: strong (Tier 1) , moderate (Tier 2), and promising (Tier 3) evidence of effectiveness, or demonstrates a rationale to be effective (Tier 4).

This product meets the requirements for Tier 4:

- ✓ Includes a logic model based on research
- ✓ A study is planned and/or currently underway
- ★ A third-party research organization has reviewed the documentation for ESSA validation



When product designers leverage learning sciences to design their programs, educators can better target instruction, and students' skills soar. Through interviews with the product designers, an evaluation of their research-informed activities, and a planning of an efficacy study, this product meets the criteria for LXD Research's ESSA Tier 4 Evidence.

– Rachel Schechter, Ph.D., Founder of LXD Research



BuddyBooks Foundational Research

ObjectiveEd's BuddyBooks is designed to improve reading outcomes for struggling readers.



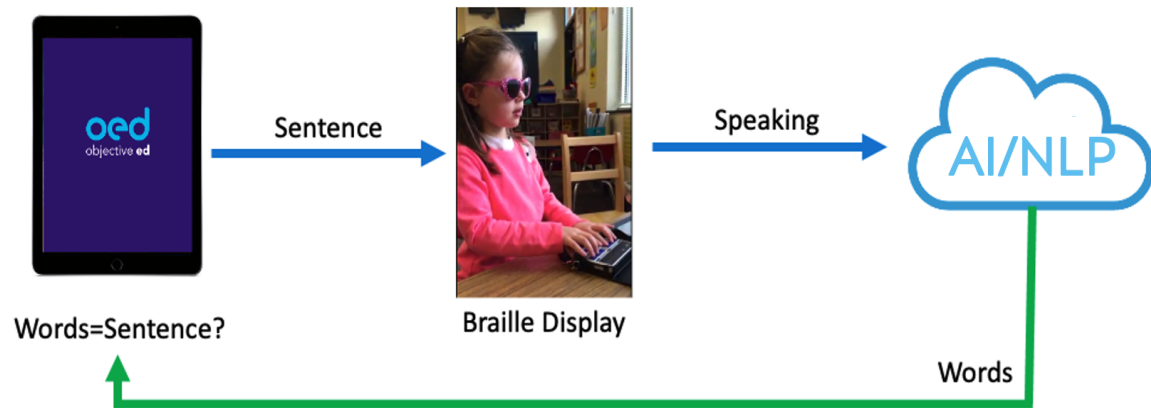
The need for BuddyBooks was driven by the literacy crisis in America. Biennial testing through the Urban Institute's National Assessment of Educational Progress consistently shows that two-thirds of U.S. children are unable to read with proficiency (NAEP, 2023).

While school is the typical setting for students to build literacy skills, many teachers find they do not have sufficient time and resources to ensure that every student receives sufficient individualized instruction to build these skills (Donegan & Al Otaiba, 2020). These findings align with broader studies indicating that teachers face significant obstacles in implementing intensive, individualized interventions, which are often necessary for struggling readers to make meaningful progress (Flynn & Swanson, 2012). This lack of time and resources for tailored instruction is a key factor in the persistent literacy gaps seen in many classrooms today.

BuddyBooks uses methods for supporting student reading backed by the findings of peer-reviewed research studies in cutting-edge AI-based EdTech products. BuddyBooks provides modeling, individualized feedback, and guidance to struggling readers that supports improvement in oral reading fluency, accuracy, and duration.

BuddyBooks Overview

BuddyBooks is based on an innovation that ObjectiveEd created for students with a vision impairment (VI) called Braille AI Tutor. Braille AI Tutor, built under a Microsoft AI for Accessibility grant, uses a combination of Natural Language Processing (NLP) and Gamification to help VI students learn and practice braille. Using a refreshable braille display, VI students orally read one sentence at a time from a short story that a teacher provides. Braille AI Tutor analyzes the student's oral reading, and if it matches the sentence, the student gains points in a treasure-hunting game.

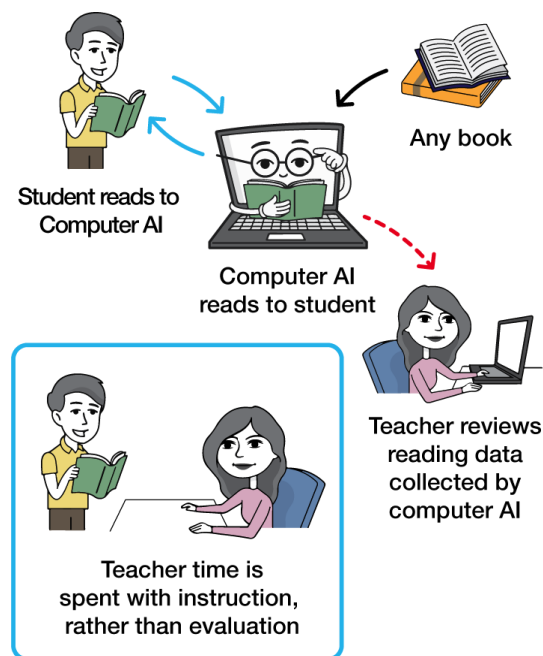


Under a National Science Foundation SBIR Phase 1 grant (NSF, 2022), BuddyBooks developers collaborated with research scientists to apply elements of the Braille AI Tutor to create BuddyBooks. Instead of a braille display, BuddyBooks uses the screen. Instead of a teacher writing a short story, BuddyBooks includes over 1 million fiction and nonfiction books from [Bookshare](#), one of ObjectiveEd’s partners. Instead of the students reading by themselves, BuddyBooks provides an oral shared-reading experience with a computer.



Under a National Science Foundation Phase 2 grant (NSF, 2024), the BuddyBooks system was extended to provide an engaging and effective fluency and comprehension improvement system. Using almost any book, the student and computer co-read, which keeps the student engaged in the story. Since the student is reading aloud every other sentence, it is a lower cognitive load than if the student was solely responsible for all the reading (Sweller et al., 2019; Sweller, 2020). That means some students can be reading stories at their interest level, instead of their reading-skill level. This is key for struggling readers who might think the books available at their reading-skill level are too immature. At the same time, as the student reads aloud, BuddyBooks

continuously analyzes students' reading accuracy and fluency, helps them where they struggle, and shows the teacher, in a web dashboard, where they need additional support.



Another important feature of BuddyBooks is that it engages the student in a conversation about the story using generative AI, which helps support reading comprehension skills (Essel et al., 2024; Xu et al., 2022; Zhai, 2023). BuddyBooks replicates the role of the teacher to provide individualized comprehension instruction.

Components of Buddy Books

A reading session with BuddyBooks consists of two phases:

- **Co-reading.** The computer and the student alternate oral reading. This can be done in one of three modes depending on the students' reading level:
 - *Echo mode:* the computer speaks a sentence, highlighting each word as it speaks, and the student orally reads the same sentence. This configuration helps very early readers.
 - *Sentence mode:* the computer speaks a sentence, highlighting each word as it speaks, and the student orally reads the next sentence.
 - *Paragraph mode:* the computer speaks a paragraph, highlighting each line as it speaks, and the student orally reads the next paragraph. This configuration helps more advanced readers.
- **Review Mode.** At the start of each session, there is a short (~5-minute) review of a passage that the student struggled with in the previous session. This mini-intervention consists of three parts for all students:

- *Model-reading*: the student hears the computer speak the passage while the student follows along.
- *Self-monitoring*: the student listens to a recording of themselves to identify the disfluency or mistake.
- *Repeated Reading*: the student is given an opportunity to re-read the passage correctly.
- **Conversational AI**. From time to time, and at the end of a book chapter, in lieu of Review Mode, there is a short (~5-minute) discussion of the passages or chapter that the student recently read. This mini-intervention is a dialog between BuddyBooks and the student, to help the student improve their reading comprehension skills. This is a multimodal conversation that can occur as a spoken dialog or as a written dialog.

Personnel involved

Researchers who collaborated on this project include experts in the Science of Reading (Dr. Doug Kostowicz, University of Pittsburgh), Accessible Education Materials (Dr. Lisa Wadors, Benetech/Bookshare), educating students with speech and language impairments (Dr. Melanie Schuele, Vanderbilt University), educating students with vision impairments (Dr. Tessa McCarthy, University of Pittsburgh), neurobiology of dyslexia (Dr. Brock Eide, author *The Dyslexic Advantage*), and reading disabilities (Dr. Laurie Cutting, Vanderbilt University).

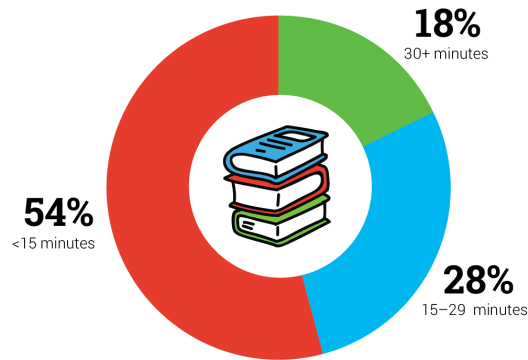
The senior development staff includes:

- Marty Schultz, ObjectiveEd President and Principal Investigator on the NSF Phase 1 grant.
- Luke Voelk, ObjectiveEd CTO, architect of BuddyBooks and Principal Investigator on the NSF Phase 2 grant.
- August Voelk, ObjectiveEd Product Manager for BuddyBooks
- Jason Stewart, ObjectiveEd Director of Customer Success for BuddyBooks, and a former Special Education Administrator in several Texas school districts.

More reading leads to stronger skills

BuddyBooks is based on the simple concept that the more a student reads, the more their reading skills will improve. Although this seems like a straightforward theory, in practice, students in the U.S. are not reading enough and need support. A study conducted on the reading practices of more than 9.9 million U.S. K-12 students found that more than half of the students read less than 15 minutes per day on average (Renaissance Learning, 2016).

**Most students read
less than 15 minutes per day**



Renaissance Learning, 2016

Fewer than one in five students averaged a half-hour or more of daily reading practice, and fewer than one in three read between 15 and 29 minutes on a daily basis. The problem is that less than half of students are reading for 15 minutes a day, yet this seems to be the “magic number” at which students start seeing substantial positive gains in reading achievement (NCES, 2013).

An analysis comparing the engaged daily reading practice and reading scores of more than 2.2 million students (NCES, 2013) found that students who:

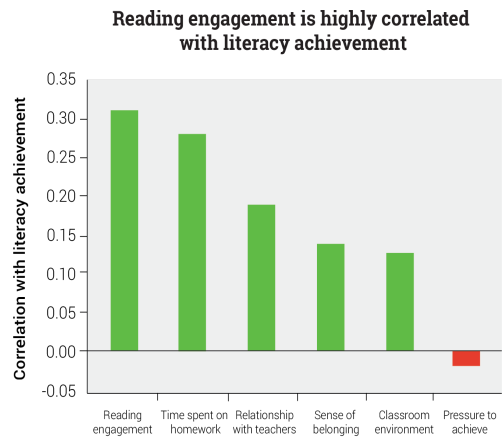
- Read less than five minutes per day saw the lowest level of growth
- Read 5–14 minutes a day saw sluggish gains that fell below national averages
- Read 15 minutes or more a day saw accelerated reading gains higher than the national average
- Read just over a half-hour per day saw the greatest gains of all

An analysis of more than 174,000 students’ Programme for International Student Assessment (PISA) scores revealed that the connection between daily reading practice and reading performance was “moderately strong and meaningful” in all 32 countries examined—including the United States (Kirsch et al., 2002).

For students within the United States, **daily reading practice may not simply be more important than socioeconomic status—it may also be more important than many school factors** (Renaissance Learning, 2016). Considering only American students’ PISA scores, reading engagement displays a higher correlation with reading literacy achievement than:

- Time spent on homework
- Relationships with teachers
- A sense of belonging
- Classroom environment
- Pressure to achieve (which has a negative correlation)

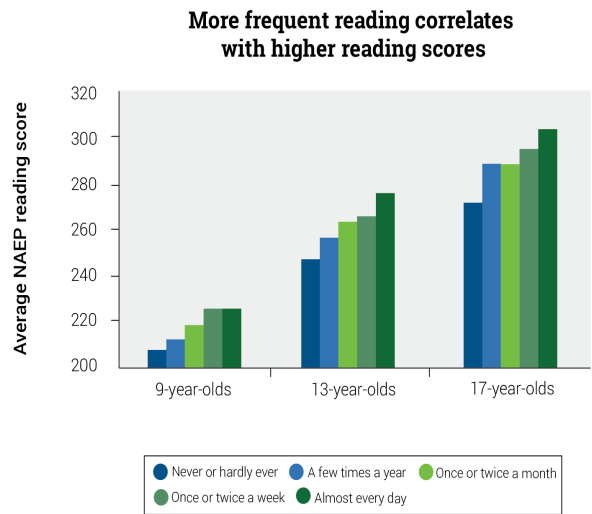
In addition, a regression analysis showed an increase in achievement across all measures of reading literacy performance when daily reading practice increased, as seen below.



Renaissance Learning, 2016

In 2013, the National Center for Education Statistics (NCES) compared students’ National Assessment of Educational Progress (NAEP) reading scores with their reading habits (NCES, 2013). For all age groups, they found a clear correlation between the frequency with which students read for fun and their average NAEP scores.

The more frequently students read, the higher their scores were, as seen below.

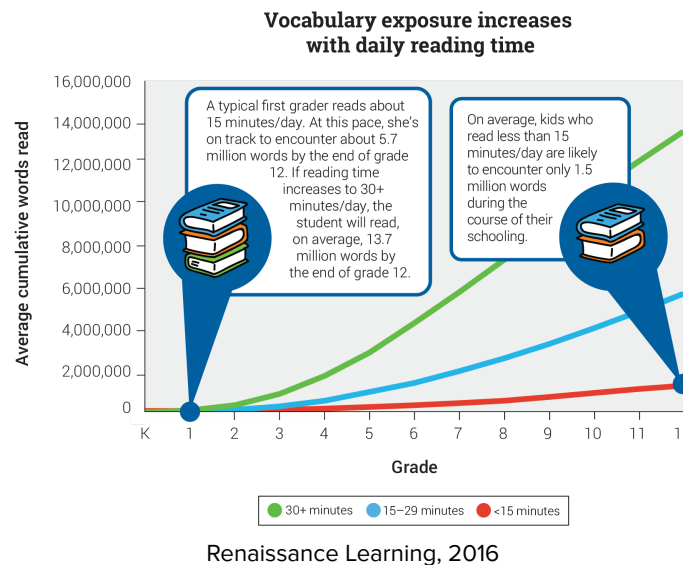


Renaissance Learning, 2016

Vocabulary growth

Students with an average daily reading time of 30+ minutes between kindergarten and twelfth grade are projected to encounter 13.7 million words. By contrast, their peers who averaged less than 15 minutes of daily reading practice are likely to be exposed to only 1.5 million words.

By the time these students graduate, the difference between these two groups is more than 12 million words (Renaissance Learning, 2016).



Vocabulary plays a critical role in reading achievement. More than half the variance in students' reading comprehension scores can be explained by the depth and breadth of their vocabulary knowledge—and these two vocabulary factors can even be used to predict a student's reading performance (Qian, 2002). There is a relationship between vocabulary and reading achievement clearly in the NAEP scores. The students who had the highest average vocabulary scores were the students performing in the top quarter (above the 75th percentile) of reading comprehension. Similarly, students with the lowest vocabulary scores were those who were in the bottom quarter (at or below the 25th percentile) in reading comprehension (NCES, 2015). The additional 12 million words that a student could be exposed to by reading 30+ minutes a day could potentially have a huge impact on their success. BuddyBooks is designed to make reading enjoyable and engaging so that reading time increases. As a student spends more time reading, their vocabulary and reading skills improve.

In summary, BuddyBooks provides individualized instruction to struggling readers that aims to help them achieve longer reading durations, increased fluency and improved reading accuracy.

What is computer-based co-reading?

Computer-based co-reading is when a computer and student take turns reading aloud. The aim is to increase comprehension and enjoyment.

Mimicking Parent-Led Literacy Activities.

Parents who engage in shared reading activities at home significantly enhance their children's reading acquisition, vocabulary, and early literacy skills (Silinskis et al., 2020). Shared reading at home improves children's reading acquisition and independent reading habits (Crossley et al., 2016; Evans et al., 2000; Lauricella et al., 2014; McClure et al., 2017). BuddyBooks mimics this by designing a system where the child reads alternate sentences with the app, closely replicating the shared responsibility seen in parent-child reading. This emulates the dual nature of interaction, where parents would read aloud the text and the child would follow along visually.

Not only do instruction and practice in oral reading help children in the many situations in which they must read aloud, but oral reading also helps children learn to understand and interpret the texts that they are reading (Alqahtani, 2020; Harpine, 2019; Robinson et al., 2019).

Many parents do not have the time, and some do not have the mastery of the English language, to co-read with their children. Additionally, parents may inadvertently increase a struggling reader's anxiety by interrupting with corrective feedback (MacDonald et al., 2021). BuddyBooks can be an especially useful tool for these busy families with co-reading and Review Mode that will be described in subsequent sections. It uses the core principles of shared reading between parents and children in the design of the app's interactive features. BuddyBooks introduces alternating sentence reading with visual word highlighting, allowing children to hear words they may not know pronounced by the computer, and develop fluency and confidence with a lower cognitive load. Students are also able to engage with more advanced texts, similar to how parents scaffold literacy learning by guiding children through early reading experiences.



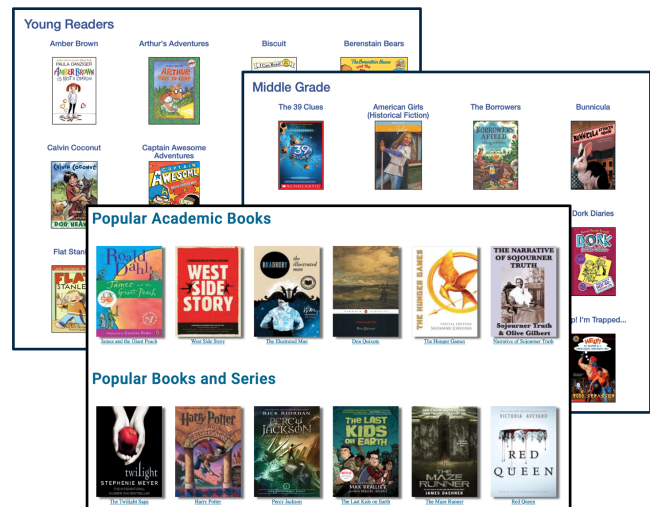
How does BuddyBooks help students to read?

Providing books that are effective

Books, such as fiction and non-fiction books, are effective in improving reading skills and will result in longer reading duration compared to other reading materials like comics, text messages, or reading on the internet (Baer et al., 2007; Jerrim et al., 2020). In particular, fiction is strongly associated with literacy benefits (OECD, 2011). Reading books should be the primary focus of recommended reading time for children, as this activity contributes the most to literacy skill development and academic achievement.

Providing a wide selection of books

Thanks to a partnership with Bookshare, funded through the U.S. Department of Education, Office of Special Education Programs, BuddyBooks provides over 1 million books (Beaumon, 2011). The BuddyBooks Bookshare collection includes K-12 textbooks, classroom reading books, and fiction and nonfiction books. The teacher selects a handful of books for each student based on their reading level, the student picks one of those books and begins reading.



Providing an opportunity for student choice

Today's teachers are required to spend most of their English/Language Arts time in teacher-directed instruction with required text, which is primarily informational or excerpts of fiction. Little, if any, time is allocated to self-selected independent reading (Garan & DeVogd, 2008), even though it is an effective classroom practice (Sanden, 2014). When students select their own books, it results in positive attitudes toward reading, higher student engagement, and increased reading achievement (Tichenor et al., 2020). Taken together, research broadly demonstrates the importance of student choice during independent reading time.

Listening-While-Reading improves comprehension, retention and vocabulary development.

Best results for reading skills can be achieved through a multimodal presentation that emphasizes both visual and auditory literacy practice, which improves comprehension, retention and vocabulary development (Wolf et al., 2019).

Mixed-modality is also known as Listening-While-Reading, where the student is supposed to track the text visually on a computer display as they listen to the computer speak the text (Esteves &

Whitten, 2011; Larson, 2015). One drawback is that students may be listening to the story without actively reading the text themselves, and this may be related to students' inability to inhibit distractions, which is critical for reading (Facoetti et al., 2003). Attentional mechanisms play a causal role in reading difficulties, and interventions that address students' attention can improve reading for dyslexic students (Shaywitz & Shaywitz, 2008). Younger students also find it difficult to maintain attention and retain information from audio content (Daniel & Woody, 2010). That is why BuddyBooks goes beyond Listening-While-Reading by emphasizing active participation during the co-reading sessions.

Mixed-modality and Active Participation:

A reading session with BuddyBooks consists of two phases:

- *Co-reading*. The computer and the student alternate oral reading.
- *Review Mode*. The computer helps the students where they struggle, as described later in this document.

In co-reading, the student and the computer alternate orally reading one sentence at a time. As the computer speaks its sentence, the words in the sentence are displayed on the screen, and each word is highlighted as it is spoken.

- For advanced students, *Buddy-Reading* can be configured for the student and the computer to read one paragraph at a time. As the computer speaks each of its sentences, that sentence is highlighted.
- For emergent readers, Buddy-Reading can be configured to *Echo Mode*. In *Echo Mode*, the computer speaks a sentence to the student as it highlights the words, and then the student orally reads the same sentence aloud.



So he kept a good distance away from the flames, and only came near to cover Dorothy with dry leaves when she lay down to sleep.

These kept her very snug and warm, and she slept soundly until morning.

When it was daylight, the girl bathed her face in a little rippling brook, and soon after they all started toward the Emerald City.

This was to be an eventful day for the travelers.

To solve the problem where a student may be listening to the story without actively reading the text, BuddyBooks requires the student to orally read every other sentence. Students cannot just sit back and passively listen, as would happen with an audiobook. **Students must actively participate in the co-reading process.** If the student does not orally read their sentence, BuddyBooks will ask “Are you still there?”

Providing a remediation lesson

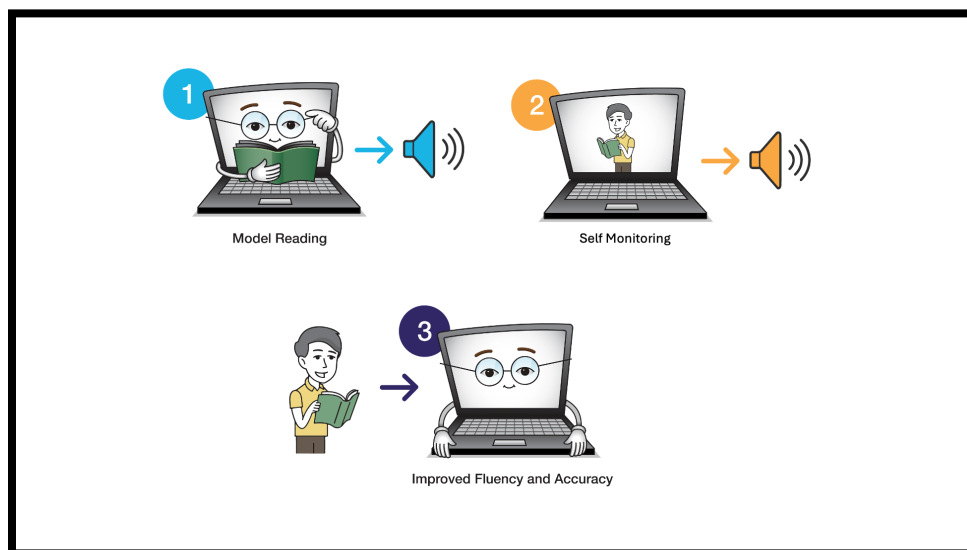
Self-correction is particularly important for beginning and struggling readers; and these readers who frequently self-correct make progress more quickly (Johnson et al., 2020). Struggling readers also experience increased anxiety when an intervention interrupts their oral reading,

which decreases their reading improvement (MacDonald et al., 2021) and their engagement (Rasinski, 2004).

BuddyBooks does not interrupt a student's enjoyment and engagement during shared reading, but instead delays the remediation when it detects a mistake. For those mistakes, at the start of the subsequent reading session, BuddyBooks provides a one to two-minute remediation called *Review Mode*.

Review Mode involves a passage where the student struggled. This passage is identified based on the last reading session's data. The remediation includes the following steps:

1. BuddyBooks speaks (model-reads) the passage to the student, so they hear how it should be read, highlighting each word as it speaks.
2. BuddyBooks plays the recording of the student's oral reading from the last session, so the student can hear how their reading differed from the model.
3. BuddyBooks gives the student another opportunity to orally read the same passage.



Model-reading

One type of remediation, known as model-reading, is where the sentence or passage is read to the student as a model. It appears to be effective in improving reading fluency and overall reading abilities for students with a reading disability (Daly & Martens, 1994; Gooch et al., 2016; Mize & Park, 2021; Vaughn et al., 2003). Model-reading is an opportunity for students to hear the text and words they may not know pronounced correctly.

Self-monitoring

Another type of remediation, self-monitoring, is where the student listens to their own oral reading. Many students will notice their mistakes during playback and improve their oral reading

in subsequent reading of the same text. Building this habit of self-monitoring and self-correction supports all students' development of their metacognition as they learn to consciously observe their own behavior while oral reading (Forbes et al., 2004). This can also positively increase students' reading fluency, comprehension accuracy, and their overall academic achievement (Brown, 2020). For students with a reading disability, self-monitoring has been shown to improve a student's reading performance (Joseph & Eveleigh, 2011; Kanani & Haghgoo, 2017). Additionally, because students are hearing their mistakes individually with a computer and not through a teacher, parent or peer, they are less likely to be embarrassed about having made a mistake, which can increase their overall reading confidence.

Repeated reading

Remediation that includes self-monitoring and repeated reading (of the same text) is effective in improving fluency and comprehension (Hawkins et al., 2015). They found that the importance of error correction and the ability to monitor one's reading is crucial for improving both fluency and comprehension. Having the opportunity to correct errors may also help increase readers' self-efficacy and independence.

Collaborative interaction supports comprehension

Collaborative Strategic Reading (CSR) is when a student actively participates in discussing the text with a teacher and it improves comprehension (Vaughn et al., 2003). By prompting students to reflect on what they had read, teachers help students to engage with the material at a deeper level, promoting higher-order thinking and better comprehension outcomes.

As beneficial as it can be, in many classrooms, teachers do not have enough time to provide structured individualized support, such as CSR, to every student.

Conversational AI for collaborative interaction

BuddyBooks provides a generative AI conversation app to replicate the role of the teacher in providing this structured support, guiding students through reading comprehension strategies and offering personalized feedback, much like CSR does in traditional classrooms.

Sample BuddyBooks (BB) Conversational AI

BB: Hi there! I see you've been reading a part of 'Tom Swift and His Motorcycle.' Tom just had a pretty intense encounter with Andy Foger, didn't he? What did you think about Tom's reaction to Andy after the near accident?

Student: It felt pretty scary.

BB: It definitely sounds like a tense moment! Tom seemed really shaken up. Why do you think Tom was so upset with Andy?

Student: He thought Andy should know better about driving too fast.

BB: Absolutely, Tom was upset that Andy was being reckless on the road. How do you think this history between them influenced Tom's reaction?

Student: I'm not sure.

BB: No problem - let's think about Andy's behavior. During and after the incident, Andy blamed Tom for getting in the way and dismissed the situation by making excuses. How do these actions show Andy's personality?

Student: He might be a bully.

BB: Exactly! Andy's dismissive behavior makes him seem like a bully. He even tries to shift the blame onto Tom, who did nothing wrong.

BB: Now let's get back to the story.

How does BuddyBooks help teachers?

Learning Analytics on student progress

Learning Analytics displaying student progress enables teachers to quickly identify where each student needs targeted instruction.

Learning analytics dashboards display student progress data to help teachers better cater to students with different learning needs. To effectively implement learning analytics tools, teachers need to perceive these tools as easy to use and beneficial to their teaching practices (Rienties et al., 2018). Providing effective professional development opportunities focused on the use of learning analytics ensures teachers can fully leverage these tools in supporting students' learning.

Additionally, there are several studies that support the use of learning analytics to analyze and enhance learning in K-12 education (Baker & Koedinger, 2018; Barton et al., 2018). The best types of learning analytics are those that consider data sensemaking heuristics, such as comparing, monitoring, and exploring information displayed by a digital tool (Molenaar & Knoop-van Campen, 2019). Rienties et al. (2018) found that learning analytics helped teachers address different learning needs of their students.

Easy-to-use Teacher Dashboard

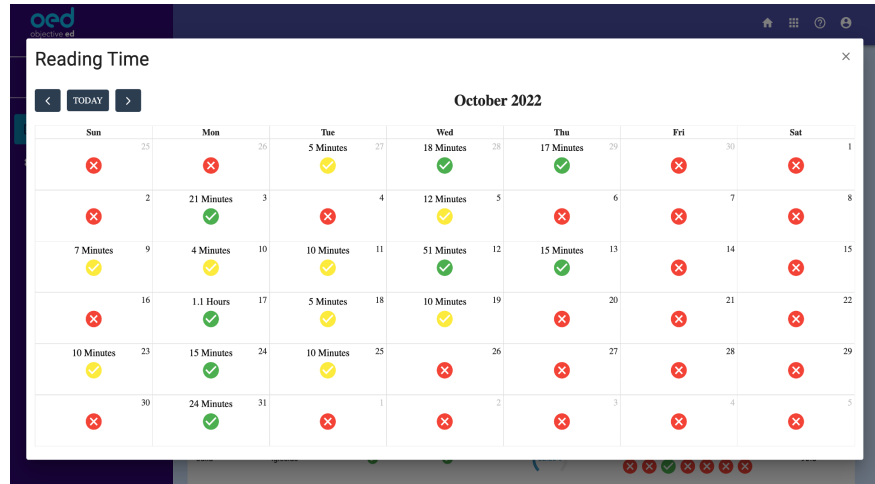
BuddyBooks provides a user-friendly and simple Teacher Dashboard, designed so that teachers can easily navigate and interpret data without feeling overwhelmed. The dashboard allows teachers to see an overview of all students or take a deep dive into one student's data, if needed. BuddyBooks offers detailed insights on student fluency, accuracy, and reading habits, allowing teachers to personalize instruction for each student based on their specific challenges.

To ensure teachers are properly trained and supported, the dashboard comes with built-in help resources and training materials. These materials help teachers understand how to apply the insights to tailor their instruction effectively.

The BuddyBooks web-based Teacher Dashboard includes many charts, such as:

Reading time for a student over the past month

Green: Student read for the full assigned duration.
Yellow: Student read, but not for the assigned duration.
Red: Student did not read that day.



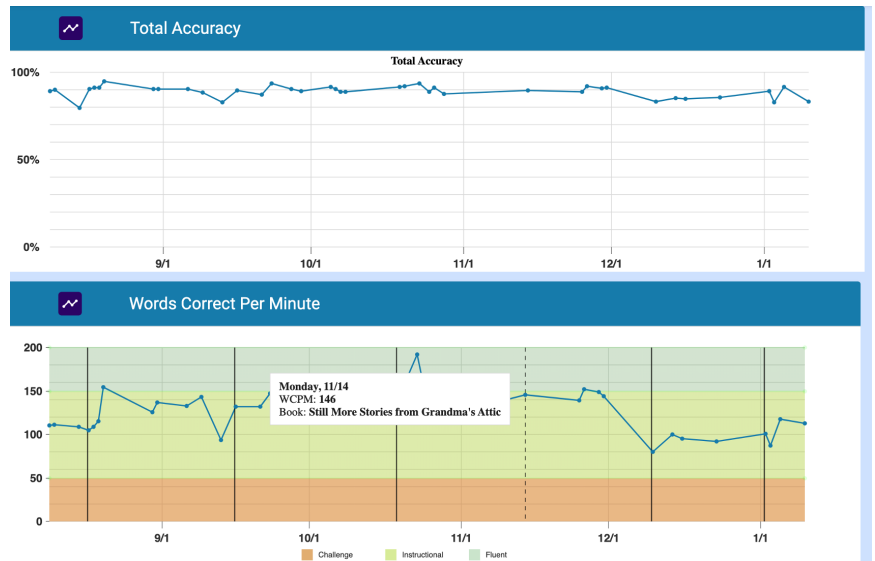
Last 7 days for all students

Shows student name, the book they are currently reading, percent completion, reading duration for the past week and accuracy.

Staff Dashboard						
First Name	Last Name	Can Login	Active Book	Progress on Active Book	Reading Time	Accuracy Score
Anna Leigh	Stewart	✓	✓	52.86%	Fri Sat Sun Mon Tue Wed Thu Yellow Red Red Green Green Green Red	88.9
Ava	Iglesias	✓	✓	84.18%	Fri Sat Sun Mon Tue Wed Thu Red Red Red Green Red Red Red	84.8
Ben	Iglesias	✓	✓	94.92%	Fri Sat Sun Mon Tue Wed Thu Red Red Red Red Red Red Red	87.3
Hannah	Iglesias	✓	✓	61.88%	Fri Sat Sun Mon Tue Wed Thu Red Red Red Green Red Red Red	89.6
Julia	Iglesias	✓	✓	82.20%	Fri Sat Sun Mon Tue Wed Thu Red Red Red Green Red Red Red	90.3
Reed	Stewart	✓	✓	13.78%	Fri Sat Sun Mon Tue Wed Thu Yellow Red Red Yellow Green Green Red	90.7

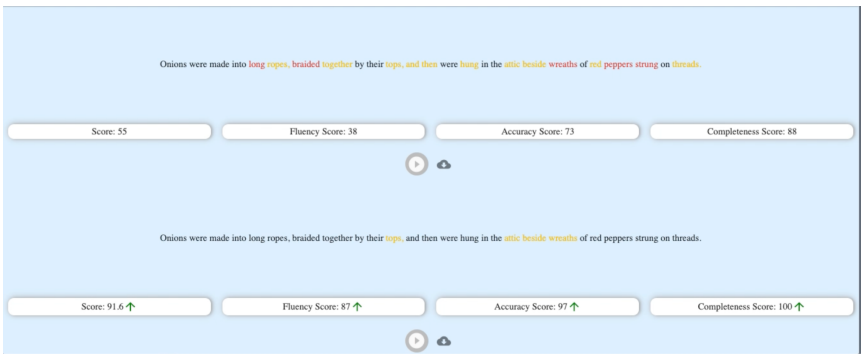
Accuracy and Fluency

For the student, shows total accuracy per day, and fluency (measured in correct words/minute) for each day. As you move the mouse across the data points on the chart, you can see details such as the date, fluency and book.



Listen to a student's oral reading

The teacher can see the before & after results of Review Mode, and view the fluency, accuracy and completion scores as well as listen to the student's oral reading (before & after).



Identifies Problem Areas

The dashboard not only provides real-time data but also allows teachers to interact with the system by listening to students' mistakes and analyzing performance at granular levels (sentence, word, phoneme).

Below is one of the charts in the Teacher Dashboard depicting *Review Mode*, BuddyBooks' micro-intervention. BuddyBooks identifies each passage where the student struggled (from 8/16 to 9/19) and the accuracy score of the first and second attempts.

Review Mode				
Passage	First Attempt	First Score	Second Attempt	Second Score
"No, I'm Rolf," Rolf said, giving her a baffled look.	9/19/2024	47	9/25/2024	99
"It will work," Lilah said fiercely, hugging Rolf. "It has to work!"	9/13/2024	78	9/19/2024	99
"There really is no reason, now that we've had a memorial ceremony, to spend the time and expense looking for their bodies." He held up his hands in defense as Celie gave him a murderous look. "That's what they are saying, not me."	9/4/2024	83	9/13/2024	81
"There really is no reason, now that we've had a memorial ceremony, to spend the time and expense looking for their bodies." He held up his hands in defense as Celie gave him a murderous look. "That's what they are saying, not me."	9/4/2024	83	9/13/2024	83
"Pogue, would you?" Lilah reached out a beseeching hand to him.	8/16/2024	58	9/4/2024	93
Rows per Page: 5 1-5 of 48				

One of the Teacher Dashboard charts showing the accuracy of phonemes where the student struggled.

Phonemes	
Phoneme	Average Score ↑
oy	37
zh	43
h	60
jh	61
aa	61

This chart displays the details for each time the student encountered the “zh” phoneme.

Example Passages: zh Phoneme	
Passage	Accuracy Score ↑
"Very good, Nancy," he praised her. "I'll send a couple of men out there to make moulages."	32
Nancy and Ned had a very special relationship. They'd known each other since they were kids, and when they'd first realized they loved each other, they'd thought it would last forever. But neither one was ready yet for a "forever" commitment, so occasionally they drifted apart, dating other people.	34
How was Celie to slip around the Castle as she always did, with some big man following her around? And Lilah, she knew, was fond of occasionally meeting with Pogue in private.	39
"Paper plates and cups on all occasions. A cleaning woman comes every other day," she explained.	40
"But are all those luxuries worth having murder on your conscience for the rest of your life? Think about it. We're talking about human lives."	42

Seamless implementation of Buddy Books

Teachers consistently prefer EdTech products that integrate smoothly into their established teaching methods without requiring significant changes. Studies have shown that when technology tools require minimal adaptation, teachers are more likely to adopt and use them effectively (Ertmer & Ottenbreit-Leftwich, 2010; Lindqvist, 2019). One reason for this preference is that teachers already face time constraints and heavy workloads, so learning and implementing new methods can feel overwhelming. For example, a study by Silverman et al. (2024) highlighted

that teachers tend to favor tech tools that streamline their existing practices rather than introducing new workflows that disrupt their routines.

An informal example comes from a middle school teacher who had to introduce a new digital learning platform that required students to complete group activities online, shifting from her traditional lecture style. Initially, this teacher faced challenges trying to manage both the platform and the new instructional style. She found it frustrating, as it took time away from focusing on her students' learning needs, and she had to balance classroom management with troubleshooting tech issues. As a result, her enthusiasm for the platform decreased, and she reverted to simpler tools that didn't require her to change how she taught. This kind of scenario reflects findings in the literature: teachers are more comfortable with EdTech that fits seamlessly into their daily routines without demanding drastic pedagogical shifts (Wohlfart & Wagner, 2023).

BuddyBooks is a perfect fit for D.E.A.R. (Drop Everything and Read) time or as a homework tool. Teachers simply assign books to students from the wide selection available, and students can use BuddyBooks independently during this quiet reading period or at home. Teachers use the dashboard to identify where a student is struggling. There is no need for any extra planning or changes to the teaching routine—it's a simple, low-effort way to keep track of students' progress and give them the reading support they need.



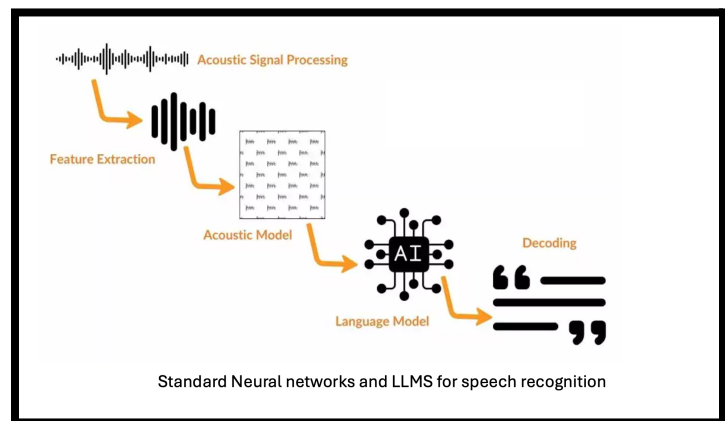
What is the technology driving BuddyBooks?

Analyzing the Student's Oral Reading

AI-based Natural Language Speech Recognition can determine a student's reading accuracy and fluency at both the word and phoneme level.

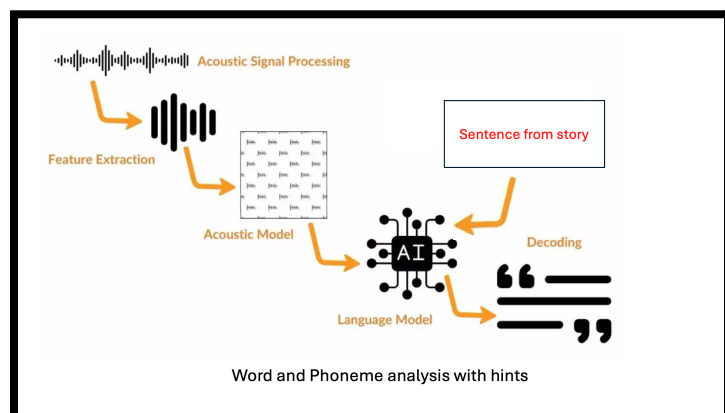
AI-based Natural Language Processing (NLP) originally focused on processing and understanding adult language in various applications, such as spoken dialogue systems and machine translation (Mostow et al., 1994; Narayanan & Potamianos, 2002). However, early attempts to adapt NLP for children's language faced challenges due to developmental differences in vocabulary, grammar, and speech patterns, which introduced variabilities that adult models could not easily handle (Gerosa et al., 2009; Strommen & Frome, 1993). Early NLP prototypes for children, such as educational games and language tutoring systems, served as testing grounds for improving these models and better understanding child-machine interactions (Bell et al., 2005; Hagen et al., 2003).

With advances in machine learning and deep neural networks, NLP systems began incorporating transfer learning, allowing children's language models to benefit from adult models. This breakthrough led to more accurate and robust child-directed NLP applications (Addlesee, 2020; Booth et al., 2020). Today, cloud-based NLP systems utilize these techniques to process children's speech and language with high accuracy in real-time, offering comprehensive language analysis and making child-directed NLP commercially viable and effective (Addlesee, 2020; Wu et al., 2019).



Word and Phoneme Speech Analysis

ObjectiveEd's current and prior research projects verified Microsoft's cloud-based NLP effectively recognizes children's speech and provides comprehensive speech analysis including phoneme identification, timing data, and probability of correctness at both the phoneme and word level. In both Braille AI Tutor and BuddyBooks, the NLP accuracy is improved by giving



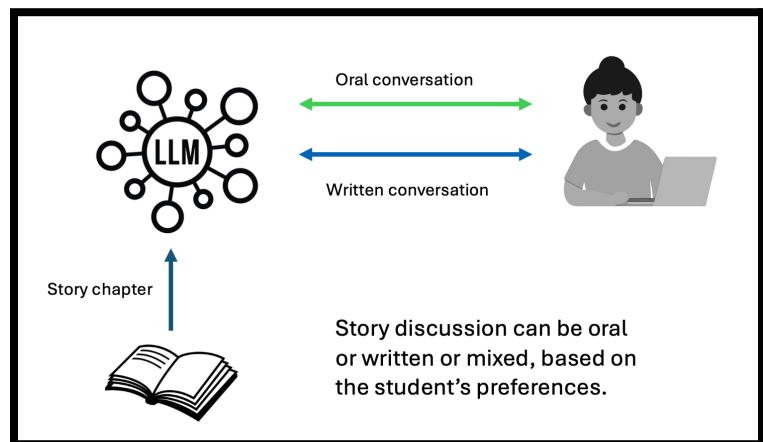
the AI a “hint” of what the child will speak: the sentence that they should orally read.

Analyzing the Student’s Comprehension

Research shows that chatbots are effective in improving students' reading comprehension and learning. Acting as conversational agents, chatbots offer personalized learning experiences with real-time feedback, helping students retain information and improve comprehension. Chatbots can guide students through reading strategies, much like human tutors, by asking questions and providing explanations (Kim, 2013; Kim et al., 2017). This interaction encourages active participation, which is essential for building comprehension skills, motivating students, and increasing engagement (Hobert & Meyer, 2019; Liu et al., 2022).

Not only does generative AI help improve comprehension through conversation, but the chatbots can model reading comprehension to support students’ underlying skills (Zhai, 2023). Additionally, chatbots can also improve students’ critical, reflective, and creative thinking skills discernibly (Essel et al., 2024; Xu et al., 2022).

BuddyBooks uses a generative AI conversation to provide a model for students to learn the steps for analyzing and comprehending a story or educational text. This saves teachers time so they can focus on building upon these skills.



Case Study: Edna Runner Tutorial Center

In summer 2024, ObjectiveEd conducted a BuddyBooks study at the Edna Runner Tutorial Center in Jupiter, Florida. The tutorial center is a provider of after-school, spring break, and summer camp services for children in grades K-8, offering educational support aimed at increasing grade point average and self-esteem.

Methods

The study group consisted of 14 boys and 12 girls, in 4th and 5th grade grades. All students were from a low-SES region of Florida and during the school year, attended a Title 1 public school. Students used BuddyBooks for 30 minutes each day, at least 3 times per week, for 5 weeks.

As noted above, BuddyBooks provides three configurations for individualized instruction:

- *Echo mode*: the computer speaks a sentence, highlighting each word as it speaks, and the student orally reads the same sentence. This configuration helps very early readers.
- *Sentence mode*: the computer speaks a sentence, highlighting each word as it speaks, and the student orally reads the next sentence.
- *Paragraph mode*: the computer speaks a paragraph, highlighting each line as it speaks, and the student orally reads the next paragraph.

To determine the baseline reading level, each student read several paragraphs. One paragraph was created for each of the grades, from Grade 1 to Grade 5. Students were assigned a reading level based on their successful reading of that grade's paragraph. Students who could not successfully read the Grade 1 paragraph were assigned to Level 0.

Level	Reading Grade	Configuration / Level	Number of students
0	K-1st	Echo Mode	1
1	1st-2nd	Sentence mode (I Can Read Level 1)	1
2	2nd-3rd	Sentence mode (I Can Read Level 2)	14
3	4th-5th	Paragraph mode (I Can Read Level 3)	7
4	6th-7th	Paragraph mode (I Can Read Level 4)	3
5	7th-8th	Paragraph mode (I Can Read Level 5)	0

Books were assigned to students based on their reading level (0-4). Students could read any of the following books at their reading level.

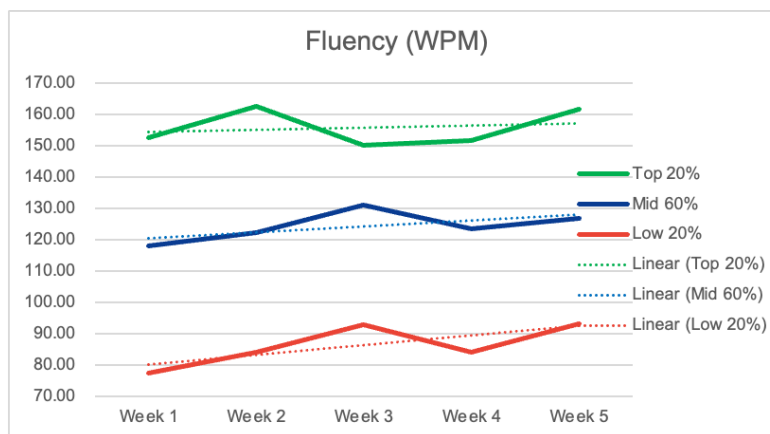
Level	Books available for students during the 5 weeks
0	Nate the Great; Swim, Mo, Swim!; The Berenstain Bears - The Big Honey Hunt; Biscuit and the Little Pup; An Elephant And Piggie Biggie!; The Bear Detectives; Mia and the Too Big Tutu; One Fish, Two Fish, Red Fish, Blue Fish
1	Junie B. Jones Smells Something Fishy; Junie B. Jones Has a Monster Under Her Bed; Cam Jansen and the Summer Camp Mysteries; Frog and Toad Are Friends; Amelia Bedelia Helps Out; The One in the Middle Is the Green Kangaroo; Pete the Cat: Super Pete
2	Goosebumps: Night of the Living Dummy; Otherwise Known as Sheila the Great; Dogs Don't Tell Jokes; How to Be Cool in the Third Grade; A to Z Mysteries: The Missing Mummy; Cam Jansen: Mystery of the U.F.O.; The Stories Julian Tells; Hello, Ninja. Hello, Stage Fright!; The Girl With a Mind for Math
3	Spelling Pen in Elf Land; The Magician's Nephew; Tuesdays At The Castle; The Red Pyramid; All American Girl; Best Babysitters Ever
4	Anne of Green Gables; The Hobbit; The Detective s Club: The Case of the Missing Mascot; Who Was Martin Luther King, Jr.?; Who Was George Washington Carver?; Washed Up! ; The Grim Grotto; White Fang
5	The End; When You Grow Up To Vote; The Boy Who Harnessed The Wind; Who Was Booker T. Washington?; Across Five Aprils; The Raven; Anne Frank: The Diary of a Young Girl; Dr. Jekyll and Mr. Hyde; 1984

Results from 5 weeks of BuddyBooks Usage

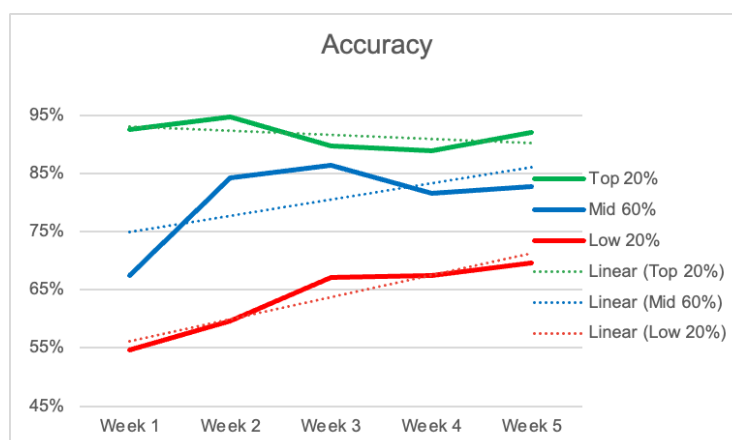
The 26 fourth and fifth grade students were segmented into 3 groups:

- Top 20% - 5 students reading at or above grade level
- Mid 60% - 16 students reading up to one year below than grade level
- Low 20% - 5 students reading two or more years below grade level

Improved Fluency: As shown in the fluency chart below, the Mid (blue) and Low (red) groups improved their fluency by about 10 Correct Words per Minute.



Improved Accuracy: Similarly, as shown in the accuracy chart below, the Mid (blue) and Low (red) groups improved their accuracy by about 13%.



Reading Skill improved by 1 Grade Level:

The Top (green) group experienced lower improvements for fluency and accuracy. These students requested more challenging books, so these students were moved to a higher grade level book selection, such as level 3 to level 4. Hence the book they read in Week 1 was easier than the book they read in Week 5, as shown below:

# Students	Week 1	Week 5
2	Level 4	Level 5
2	Level 3	Level 4

Feedback from Director and Students:

Travis Conway, Executive Director, Edna Runner Tutorial Center:



“Buddy Books was incorporated at the beginning of the summer, and I’ve seen a tremendous change with the 4th and 5th graders with them wanting to read on an online program. Once we had an opportunity to go with BuddyBooks, you definitely see the kids are trying to do and reading and actually are being engaged in the lesson.”

Students

- *“Before I read, I was kinda bad at reading. I would recommend BuddyBooks because they can help people read, get better at reading. I like the books - Dragon in the Bag, I think, Nephew's Magician, Babysitter Club.”*
- *“I enjoy BunnyBooks because it helps me learn new words and new books that I never read before.”*
- *“I had trouble, like, like, reading the lines I got confused with. It was helping me with the pronouncing it correctly and just almost everything.”*
- *“I like the stories about the BuddyBooks because it's like I feel like it's helping me become a better reader. I have ADHD. It's a little harder for me.”*
- *“With BuddyBooks, it's been helping me a lot. BuddyBooks is hard at first, and then you start progressing, and then you learn how to read fluidly.”*
- *“Because in the school year, I wasn't really a good reader that time, but now once I started doing buddy books, I feel like it helped me a lot.”*



Conclusion

BuddyBooks is a cutting-edge educational technology product designed to address the literacy crisis by improving reading outcomes, particularly for struggling readers. Built upon rigorous foundational research, it integrates evidence-based practices such as co-reading, mixed-modality learning, and self-monitoring feedback to enhance students' reading fluency, comprehension, and engagement. Through its innovative use of Natural Language Processing (NLP) and AI-driven features, including Review Mode, BuddyBooks provides personalized, interactive learning experiences that actively engage students in reading, offering feedback and support to improve literacy outcomes:

Key Highlights That Set BuddyBooks Apart:

1. **AI-Powered Co-Reading:** BuddyBooks utilizes AI to create a shared reading experience where students alternate reading aloud with the computer, promoting active participation and engagement while reducing cognitive load.
2. **Personalized Learning:** BuddyBooks tailors the reading experience to each student, offering feedback based on their unique performance, allowing for targeted, individualized instruction.
3. **Comprehensive Content Library:** BuddyBooks offers access to over 1 million books, including a diverse range of fiction and nonfiction texts, thanks to its partnership with Bookshare.
4. **Review Mode for Improvement:** BuddyBooks continuously analyzes student performance, offering a remediation lesson that includes listening to model readings, self-monitoring, and repeated reading.
5. **Seamless Integration into Teaching:** BuddyBooks fits seamlessly into a teacher's routine by allowing them to assign books, monitor student progress through the dashboard, and offer support as needed, all without requiring extra planning or changes to their teaching methods.

Big-Picture, Long-Term Goals:

BuddyBooks aims to make a significant impact on literacy development by addressing the challenges faced by students with reading difficulties. The long-term goal is to create a scalable, engaging, and effective tool that not only improves individual reading outcomes but also helps reduce the literacy gap across the nation. By providing educators with data-driven insights and students with personalized reading support, BuddyBooks strives to empower learners to become proficient readers, regardless of their starting point. Ultimately, this technology has the potential to contribute to societal improvements in literacy rates, academic achievement, and long-term educational equity.

Testimonials



"BuddyBooks is like having a second set of ears for listening to my kids read out loud."

Frances

Mother of 4 children

"Before using BuddyBooks, I had a tendency to add words. Now it corrects me when I add words, and that helps me get better."

Hannah

Student, age 11



"BuddyBooks gives my children the feedback they need to improve."

Rebecca

Mom of two kids, age 11 and age 14

"Before BuddyBooks, it was really difficult for me to monitor how my kids were reading. I had to quiz each child about what was happening in the story. Now BuddyBooks shows me."

Trish

Mom of three children



Buddy Books Logic Model

PROBLEM STATEMENT

Teachers and families of struggling readers often do not have the tools needed to support students' reading skills (Donegan et al., 2020; Flynn et al., 2022). Teachers in particular, do not have resources to address each individual student's needs, and families may not know where to start. ObjectiveEd's AI-powered reading platform, BuddyBooks, uses a combination of co-reading, model-reading, self-monitoring, continuous assessment, and socratic discussion to provide teachers and families with the appropriate tools. BuddyBooks engages students in individualized instruction with the aim of improving each student's reading fluency, accuracy and comprehension.

RESOURCES

(What resources are or could be available?)

ObjectiveEd provides:

- AI-based personalized reading practice, feedback, and ongoing assessments to support continuous improvement in reading skills.
- An opportunity for students to alternate reading lines from popular books with a computer.
- Visual and auditory presentation of books being read to students.
- Continuous assessment of fluency, accuracy and comprehension of students' oral reading.
- Review mode to correct inaccuracies in oral reading from the previous section
- A library with thousands of published fiction and non-fiction books for all ages.
- Dashboards to enable configuration of BuddyBooks for each student.
- Exportable reports identifying student reading skills including fluency, accuracy, duration of reading, problem areas, and comprehension.
- Teacher and Admin training, toolkit and resources.
- Ongoing support teacher and admin support.

District provides:

- Chromebook iPad, or other browser based computers, with Internet-connectivity to access the BuddyBooks websites.
- Noise-canceling headsets if students will be within 4 feet of each other.
- Scheduled time for using BuddyBooks.

STRATEGIES AND ACTIVITIES

(What will the activities, events, and such be?)

Teachers:

- Participate in BuddyBooks training.
- Assign a selection of books for each student to choose from, and read.
- Configure BuddyBooks for each student's individual needs.
- Review student progress that's shown on the Dashboard and Reports and provide targeted instruction based on student progress.

Students:

- Select books they want to read.
- Read aloud to Buddybooks alternating with the computer.
- Participate in oral co-reading stories at least 3 days per week, for 15-20 minutes per reading session.
- Complete review mode to improve accuracy.

Administrators:

- Onboarding of teachers to be trained in effective use of the BuddyBooks Dashboard teacher features.
- Onboarding of administrators to be trained in effective use of the BuddyBooks Dashboard admin features.
- Periodic review of the BuddyBooks progress charts to understand student's current reading skills.

Parents/guardians:

- Review student progress shown in Dashboard and Reports.
- Provide assistance recommended by the student's teacher, based on Student Progress.

OUTPUTS

(What are the initial products of these activities?)

Teachers:

- Understand how BuddyBooks can help students' reading skills.
- Review each student's fluency (Correct Words per Minute) and accuracy (percent of words read accurately) assessments.
- Review the time spent reading.
- Construct targeted instruction with dashboard information.
- Save time with BuddyBooks' continuous assessment since they do not have to assess outside of BuddyBooks.

Students:

- Choose books they are interested in because of support from BuddyBooks.
- Reduced cognitive load with the shared reading experience allows students to read longer.
- Increase in daily time and total time spent reading.
- Improve accuracy and fluency based on feedback from Review Mode.
- Better vocabulary and pronunciation based on reading with computer.

Administrators:

- Better understanding of reading levels across students and classrooms.

Parents/guardians:

- More confidence in supporting child read independently.

SHORT-TERM AND INTERMEDIATE OUTCOMES

Teachers:

- Gain access to teaching materials that are designed based on the science of reading.
- Utilize resources that streamline practice in fluency, accuracy, and comprehension.
- Increase awareness of students' specific literacy challenges.
- Provide better targeted individualized instruction to each student.
- Spend time saved by using BuddyBooks assessments to connect with students.

Students:

- Improve foundational reading skills that increase comprehension skills.
- Have greater oral reading fluency, accuracy, comprehension, and vocabulary.
- Improve oral reading confidence and stamina leading to more independent reading.
- Improve independent reading confidence.
- Higher interest and engagement in reading.
- Struggling readers and students with a learning difficulty close gaps.

Parents/guardians:

- Become more engaged in their children's literacy progress.

LONG-TERM OUTCOMES AND IMPACTS

Teachers:

- Teachers become more confident in aligning their instruction with the principles of the science of reading.

Students:

- Transfer skills they practice in BuddyBooks to other educational settings.
- Demonstrate improved reading comprehension and fluency and more engagement in reading.
- Achieve higher levels of literacy proficiency and the ability to read more complex books.
- Be better equipped for academic success in higher grade levels.
- Experience long-term benefits, such as a higher likelihood of graduating high school, pursuing higher education, and enhancing future earning potential.

ASSUMPTIONS

School leadership will enable and support the logistics of using BuddyBooks. Leadership has the skills to enable the culture change for using an AI-based reading tutor, implementing data-driven teaching, including the management of how much change is happening across the school community.

Who uses BuddyBooks?

- Students:
 - Struggling readers from 2nd to 12th grade.
 - Students with a reading disability, such as dyslexia.
 - Students who are one or more years behind in grade-level reading.
- Teachers
- School or district leaders
- Families: parents/guardians

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