An Observational Study of WORD Force

Early Literacy Digital Game-Based Learning Program Evaluation

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Executive Summary

WORD Force is an interactive, digital education product designed to improve early literacy skills in young children; it consists of 15 games focusing on early literacy skills. Prior to beginning each game, learners take a pre-game assessment of their related skill development. Each game has five levels of play with each subsequent level increasing in difficulty. After the five levels are completed, learners' skills are again measured through a post-game assessment.

The best process for determining how WORD Force aligns with the science of reading is through a phased research approach (Fey, 2014; Robey, 2004) to measure how and for whom WORD Force games work best. The first phase is comprised of observational research which includes: (a) an analysis of historical data on students' use and improvement on WORD Force games; and (b) an exploratory observational study that will provide additional information about students' literacy environment in the home and classroom, as well as perceptions of their improvement on reading-related skills before and after use of WORD Force.

The Observational Study consisted of three components:[1]

- **The User Behavior Study** analyzed the activity and course assessment data of all students who took WORD Force in the 2021-2022 school year and revealed that certain ways of using WORD Force were associated with better learning outcomes for the students:

    - The larger the variety of games the students played, the greater their skill improvement was in the pre- to post-game assessments.

    - Students with better in-game performance tended to have greater skill improvement

    - Compared to students who did all their engagement with the course in one day, those who consistently played a roughly equal number of games each day and spread out their usage across several days demonstrated greater skill improvement.

- **The Family Study** evaluated WORD Force usage within the home environment and revealed significant skill improvement (phonological awareness skills, phonics skills, sentence structure complexity and storytelling/retelling skills) for most students, based on parental reports. The number of books available for children to read at home and the frequency with which parents taught their children how to read words were the most critical home literacy environment factors. The greatest improvement in phonological awareness and phonic skills was observed among the pre-kindergarten students.

- **The Classroom Study** focused on teacher perceptions of the impact of WORD Force and showed that typical and struggling learners in pre-kindergarten, kindergarten, and first grade had greater improvement in the phonological awareness and phonics skills, while typical and struggling learners in the second grade had the greatest improvement in the spoken language skills. All students had greater improvement if their teachers received training in teaching early literacy skills. Struggling learners, in particular, had greater skill improvement if their teachers used literacy blocks in the forms of small group instruction, one-on-one instruction, independent work or peer work.

Though an observational study cannot indicate whether use of WORD Force caused the previously mentioned improvements, it did reveal rich information about the potential of WORD Force and how this course could be used to achieve the best learning outcomes. The findings further strengthen our belief in the necessity of high-quality early literacy educational programs and our confidence in using WORD Force to build a strong early literacy foundation for America's next generation.

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Introduction

National data trends show that the majority of children in the United States continue to struggle to read proficiently (NAEP, 2019). This crisis has been exacerbated by the ongoing pandemic and associated loss of instructional time, with our youngest students being most impacted (Amplify Education, 2022; Curriculum Associates, 2021; North Carolina State Board of Education and Department of Public Instruction, 2022). Reading experts identified in the science of reading literature the following "Big 5" reading skills which children must learn to address the crisis and enable them to "read to learn": phonemic awareness, phonics, vocabulary, reading fluency, and reading comprehension (National Reading Panel, 2000).
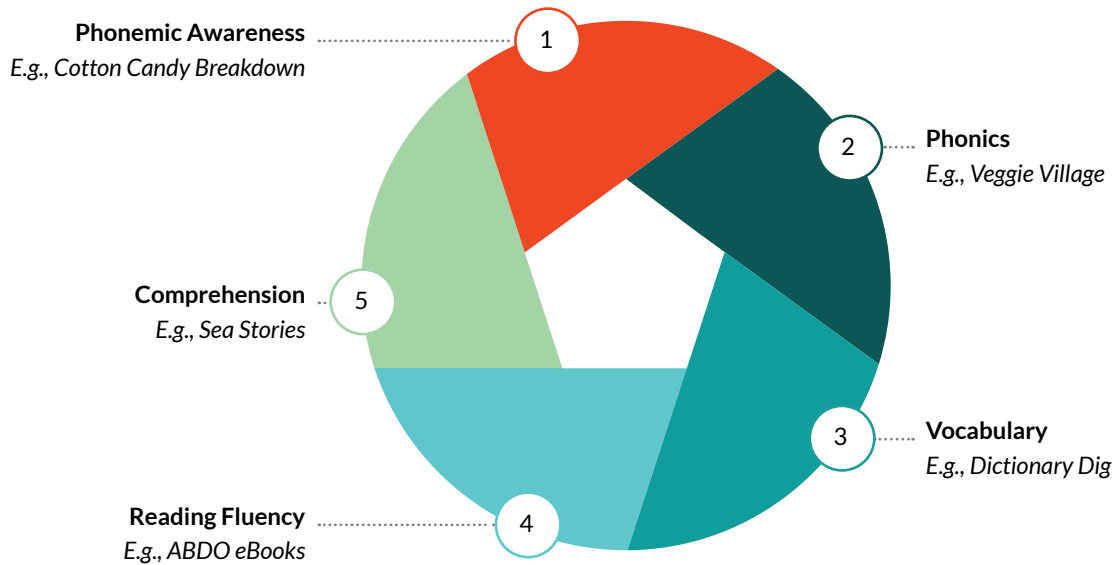
For young children nearing or just at the beginning of formal education, the pathway to achieving the Big 5 skills includes developing a strong foundation in early literacy skills like spoken language (including phonological awareness), concepts of print, early phonics, emergent spelling, and emergent writing (Armbruster, Lehr, Osborn, 2006; Armbruster, Lehr, Osborn, & Adler, 2006). Given the breadth of support needed to address the reading acquisition crisis, an all-hands-on-deck approach is required, which includes using available digital learning programs that are proven to support reading acquisition.

The interactive, digital learning program WORD Force is designed to improve early literacy skills for young children. The best process for determining how WORD Force aligns with the science of reading is through a phased research approach (Fey, 2014; Robey, 2004) to measure how and for whom WORD Force games work best. The first phase is comprised of observational research which includes (a) an analysis of historical data on students' use and improvement on WORD Force games; and (b) an exploratory observational study that will provide additional information about students' literacy environment in the home and classroom, as well as perceptions of their improvement on reading-related skills before and after use of WORD Force.

Collectively, these findings will be used to inform the development of a WORD Force efficacy study, which will be designed to uncover which games promote improvement on specific literacy skills for different subgroups (e.g., by grade level, students in low to moderate income [LMI] schools vs. non-LMI students). This report details the steps and outcomes of the observational study.

The Big 5 and WORD Force Alignment

Phonemic Awareness
E.g., Cotton Candy Breakdown 1

Phonics
2 .... *E.g., Veggie Village*

Comprehension
E.g., Sea Stories ... 5

Vocabulary
3 .... *E.g., Dictionary Dig*

Reading Fluency
E.g., ABDO eBooks 4

WORD Force Design

WORD Force consists of 15 games focusing on five different skill sets, as depicted below. Prior to beginning each game, learners take a pre-game assessment of their related skill development. Each game includes five levels of play with each subsequent level increasing in difficulty and after the five levels are completed, their skills are again measured through a post-game assessment.

Each learner's improvement in skills is reflected by the changes in assessment scores.

Early Literacy Skills covered by WORD Force:

Game Set 1 - Phonological Awareness (rhyme, onset-rime, phonemic awareness) and Phonics (letter-sound association)

Game Set 2 - Phonological Awareness (phonemic awareness) and Spelling/Word Building

**Game Set 3** - Spelling/Word Building and Vocabulary

Game Set 4 - Spelling/Word Building and Reading Comprehension

Game Set 5 - Vocabulary and Reading Comprehension

PRE ASSESSMENT | L1 | L2 | L3 | L4 | L5 | POST ASSESSMENT

Easy ———————————————→ Advanced

Our observational study phase was designed to discover (a) how students use WORD Force, (b) which early literacy skills improved during WORD Force use, and (c) student and environmental characteristics associated with the greatest improvement in early literacy skills during WORD Force use. The observational study consisted of three components:

- **The User Behavior Study** analyzed the historical WORD Force activity and course assessment data collected from students who had taken the course during the 2021-2022 school year.

- **The Family Study** followed a cohort of families with children using WORD Force while measuring parental behaviors and the literacy environment in the home. Families who had not started using the product with their children were recruited through our social media networks and partner organizations. Parents evaluated their children's early literacy skills before and after they engaged with WORD Force content (over a period of 6 weeks). We informed parents that the minimum engagement required from each learner in the study was for them to try at least three games and play for at least 1 hour.

- **The Classroom Study** focused on the improvement of students' early literacy skills in the class and considered the impact of teacher characteristics and the classroom literacy environment on student impact. EVERFI reached out to teachers through our educator network who had not yet begun using WORD Force with their students this year, but were still interested in implementation. Teachers were required to sign up at least four students (but no more than 12) from their classroom and commit to evaluating each participant's early literacy skills before and after they engaged with WORD Force content (over a period of 4 weeks). We informed teachers of the minimum engagement required from each learner in the study was for them to try at least three games and play for at least 1 hour.

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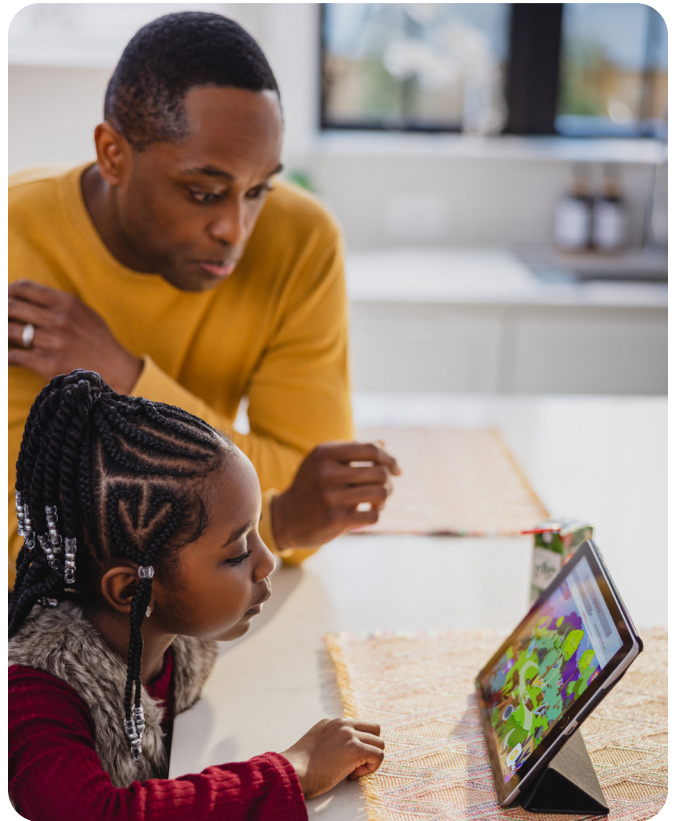
The Measurements

For the User Behavior Study, we used the course's built-in assessments to measure the students' improvement in early literacy skills. However, to get more granular data on early literacy skill development, we also wanted to query parents and teachers of WORD Force users about the changes they may have seen in their learners. Therefore, in the Classroom and Family studies, we employed independent measurement tools which covered a wide variety of early literacy skills. For the Family Study, the survey developed by Lombardino, Lieberman, and Coleman (2020) was used as the measurement tool for parents. For the Classroom study, the survey was developed based on the work of the American Speech-Language-Hearing Association, the National Early Literacy Panel, the National Reading Panel and the findings in Brady (2020), Gillon (2004), Rudginsky and Haskell (1997), and Snow et al. (1998). The skills gauged in these instruments are listed here for each study and elaborated on in the appendix:

- **The Family Study Survey**

  - Phonological Awareness y Phonics

  - Phonics
    - Alphabet and Phonics Knowledge

  - Spoken Language
    - Speech Sound Production
    - Sentence Structure Complexity and Variety
    - Grammar
    - Vocabulary Learning
    - Storytelling and Retelling

- **The Classroom Study Survey**

  - Phonological Awareness

  - Phonics

  - Spoken Language Skills

Although the measurements used in the Family and Classroom studies use somewhat different terminologies and group the skills differently than our course assessments, in general, the skills measured by the independent measurements align well with those covered by WORD Force (see the Early Literacy Skills Crosswalk Table in the appendix for the alignment of skills evaluated by the independent measurement and those covered by the course).

The outcomes measured by the independent measurement tools were compared to those measured by the course assessments. The Early Literacy Skills Crosswalk Table in the appendix summarizes the skills covered and assessed in the course and how they are aligned with the Family and Classroom study surveys. Based on factor analysis of the Classroom Survey data,[2] the course assessments and the independent measurements factor into similar underlying constructs. This finding indicates that the underlying skills (phonological awareness, phonics and spoken language skills) measured by the course assessments are aligned with the skills measured by the independent measurement tool.

Other factors that could potentially influence the children's early literacy skill development were also measured. In the Family Study survey, the parents were asked to answer questions about the demographics of the children, their social-economic status, and the home literacy environment (e.g., frequency parents taught their children how to read words/letters and the number of books the children had at home to read) (Bradley et al., 2001; Gay et al., 2020; Hamilton et al., 2016; Puglisi et al., 2017; Sénéchal, & Young, 2008). In the Classroom Study survey, the teachers also answered questions about the students' demographics, teachers' characteristics (e.g., whether they received training in teaching early literacy skills), the instructional arrangement (e.g., the use of literacy blocks), and the classroom literacy environment (e.g., whether the students had free access to books in the classroom) (Ball & Gettinger, 2009; Baroody & Diamond, 2016; Gay et al., 2020; Piasta et al., 2019).

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[2]Factor analysis is a common statistical method used to identify the number of underlying constructs survey questions measure and how strongly each survey question is related to each underlying construct.

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The User Behavior Analysis

For the User Behavioral Study, we analyzed the usage and course assessment data for all the students in the 2021-2022 school year. Multiple regression analysis was conducted to show the correlation between the students' usage patterns and the skill improvement they achieved.[3] Since this analysis used course data, and EVERFI does not survey students under 13 years old, we were unable to collect or control for students' demographic characteristics. The results revealed correlations between different usage patterns and the assessment score improvements.

On average, the students played four WORD Force games on 3 active days (days when they played at least one game). We also found that 37% of the students only used the course for only 1 day.

Although WORD Force can be used in a variety of ways that meet the needs and schedules of teachers and students, our analysis revealed that certain patterns of usage were correlated with greater improvements in early literacy skills.

First, students who played a greater variety of games showed greater skill improvement as reflected by their pre- to post-assessment score changes. Specifically, students who played less than 10 games had a 2.8% improvement in their assessment scores, whereas those who played 10 or more games had an average improvement of 8.3%. Second, compared to the students who finished the course in one day, those who used the course more consistently, i.e., spreading out their usage across several days and playing a roughly equal number of games each day tended to have greater skill improvement as well (see Score Improvement and Consistency of Use scatterplot).

Finally, students with better in-game performance, i.e., having more correct answers to in-game questions, had greater improvement (figure to the right). Although this current version of WORD Force does not have a formal "teaching" component in the games, this positive correlation between in-game performance and assessment score improvement suggests that as students played through the games, they learned and acquired new skills.

Score Improvement and Consistency of Use
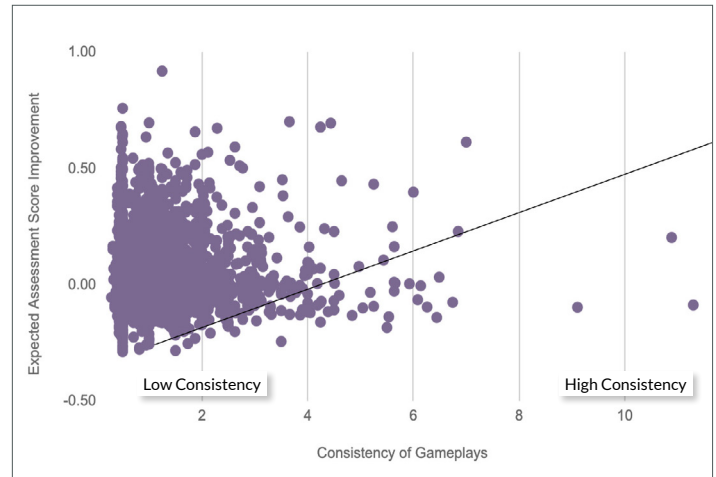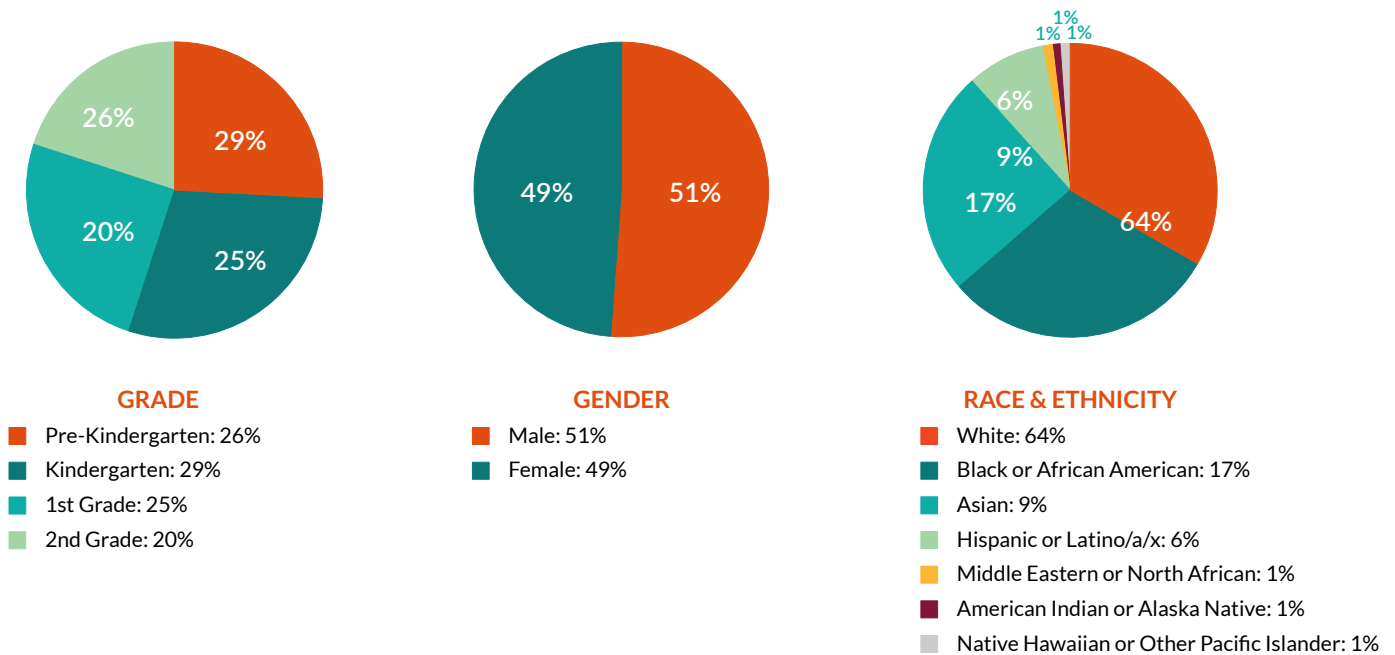

Score Improvement and In-Game Performance

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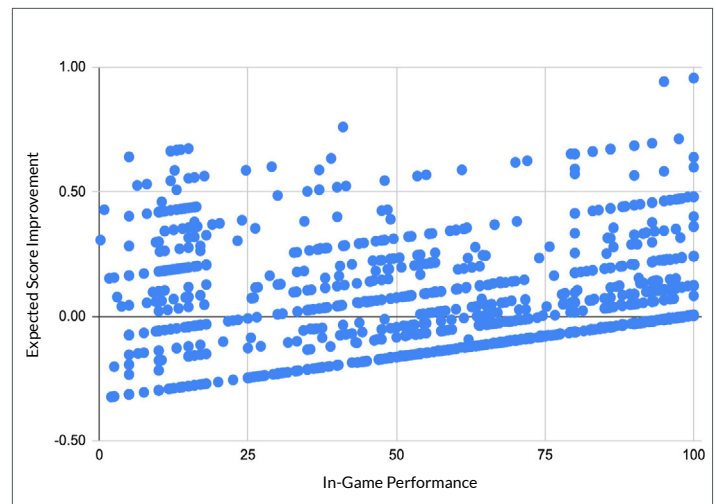
[3] Multiple regression is a common statistical technique used to show how a number of factors (i.e., different usage patterns in this analysis) are related to a dependent variable (i.e., the skill improvement in this study). Multiple regression differs from a simple correlation analysis in that it shows the unique correlation of each factor to the outcome variable by controlling for the influence of other factors.
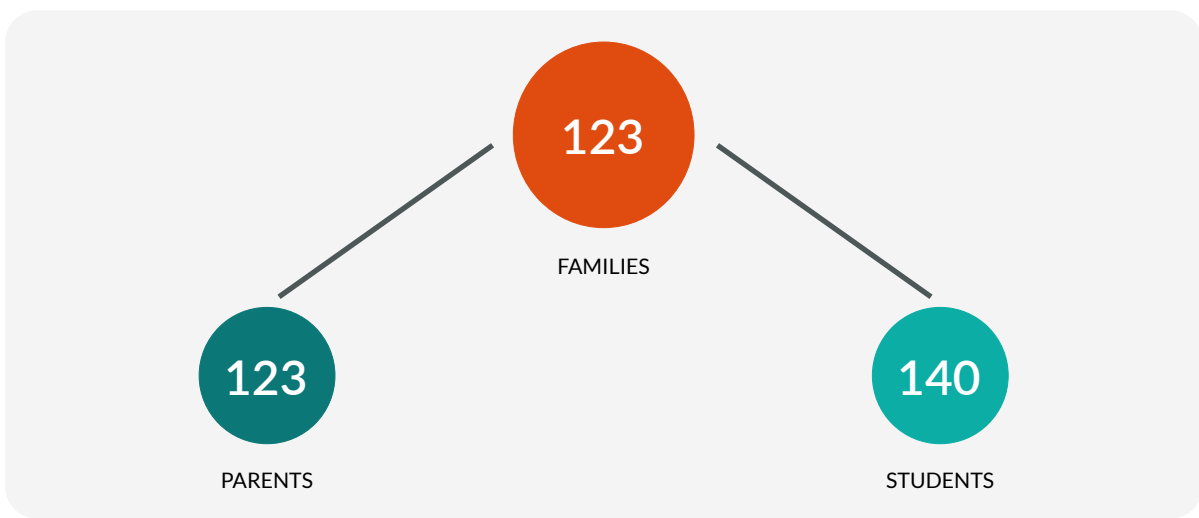
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The Family Study

The Family Study focused on the improvement of students' early literacy skills as they used the course at home. To evaluate if the learners' skills were significantly improved after they used the course, a linear mixed model was estimated with the pre-course skill score,4 child characteristics, parent characteristics, and home literacy environment added as control variables. Then, to reveal what factors could influence the skill improvement, another regression analysis of the participants' skill improvement on the parent characteristics, children characteristics, and the home literacy environment was conducted also using the linear mixed model method.

Children

GRADE
- Pre-Kindergarten: 26%
- Kindergarten: 29%
- 1st Grade: 25%
- 2nd Grade: 20%

GENDER
- Male: 51%
- Female: 49%

RACE & ETHNICITY
- White: 64%
- Black or African American: 17%
- Asian: 9%
- Hispanic or Latino/a/x: 6%
- Middle Eastern or North African: 1%
- American Indian or Alaska Native: 1%
- Native Hawaiian or Other Pacific Islander: 1%

Family Sample Demographics

123 FAMILIES

123 PARENTS

140 STUDENTS

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4 Linear mixed modeling is an advanced statistical technique which extends simple multiple regression to accommodate for cases where the sample has a hierarchical structure. In this study and the classroom study, the participating children were sampled from families or teachers. In this case, linear mixed modeling should be used instead of simple multiple regression to produce consistent and unbiased estimates.

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English Language Learners (ELL) (8%)

23% of the students had at least one type of disability that could impact their learning

- Developmental delay (n=22)
- Specific learning disabilities (n=4)
- Other health impairments (n=14)
- Speech and language impairments (n=28)
- Visual impairment (n=4)
- Intellectual disabilities (n=4)

Home Literacy Environment

- 78% of parents reported that they often or very often read stories to their children
- 79% spent at least 2 hours reading to their children per week
- 78% of parents said they often or very often taught their children letters
- 72% said they often or very often taught their children words
- 89% of parents reported that they often or very often engaged in extended conversations with their children
- 85% of parents reported that there are over 40 books for their children to read at home
- Only 40% of parents read habitually in their personal time

The children's early literacy skills were measured before they started using the course. The analysis suggests that children's baseline skills varied according to their demographics and their home literacy environment.

Child Characteristics

Compared to males, females showed more interest in books (figure below) and were better at using a greater variety of sentence structures when they spoke. Older children performed better on speech sound production, grammar, phonological awareness, and phonics tasks. Older children also showed more interest in words, but children with disabilities lagged behind in all aspects of early literacy skills.
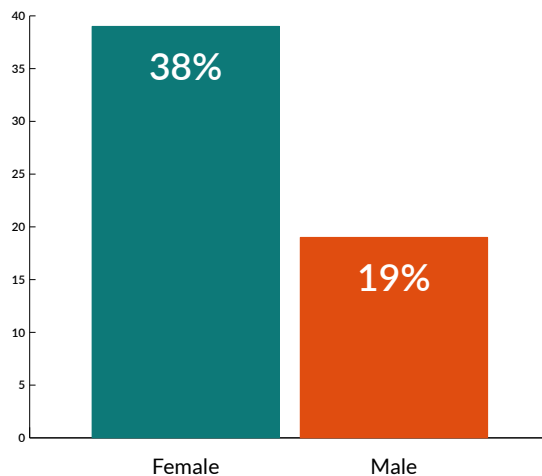
Parents

88%

88% of the parents were married or in a domestic partnership

50%

50% of the parents had a bachelor's or higher degree

Percent Of Participants Who
Have A Strong Interest In Books

38%

19%

Female   Male

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Home Literacy Environment

Several home literacy environment factors were found to be related to early literacy baseline skills. The analysis showed that the number of books at home for children to read, the frequency that parents reportedly taught their children words and the frequency that the parents had extended conversations with their children were critical home literacy environment factors. The number of books available at home was correlated with higher baseline measures of all skills except for grammar and speech sound production. As frequency of parental instruction increased, so did all baseline skills except grammar, vocabulary, and storytelling/retelling ability. Extended conversations in the home were related to higher levels of early literacy skills but especially phonological awareness (figure below).

We also found that children of parents who read to them frequently seemed to have a higher general interest in books, but that none of the early literacy skills at baseline varied based on the parents' reading habits. Baseline abilities appeared to be very related to interactional behaviors between parent and child, but uninfluenced by modeling behaviors.

Skill Improvement

For children who used the WORD Force program, several early literacy skills were significantly improved, though children with reported learning difficulties experienced less improvement than their peers in all skills.
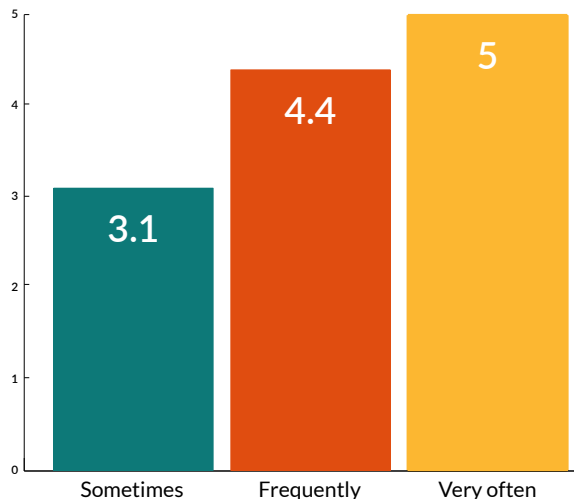
Phonological Awareness

According to parents, the percentage of participants who possessed all the phonological awareness skills we measured increased from 31% in the pre-course survey to 45% in the post-course survey.

Specifically, children in pre-kindergarten showed the greatest improvement in phonological awareness compared to those in other grades. Greater improvement was also correlated with children having more books to read at home, having parents who read to them more often, and having parents who focused on teaching them how to read letters and words throughout the day.

Alphabet and Phonics Knowledge

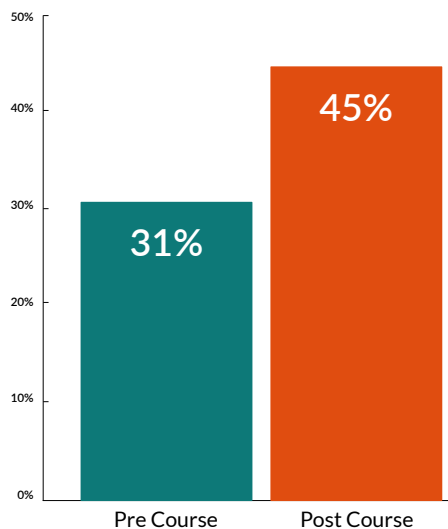The percentage of participants who possessed all the alphabet and phonic skills measured increased from 46% in the pre-survey to 56% in the post-course survey. Again, children in pre-kindergarten showed the greatest improvement compared to other grades and higher improvements were correlated with more books available at home and parents who taught their children words and letters more often.

PHONOLOGICAL AWARENESS SKILL SCORE (OUT OF 7) S. FREQUENCY OF EXTENDED CONVERSATIONS
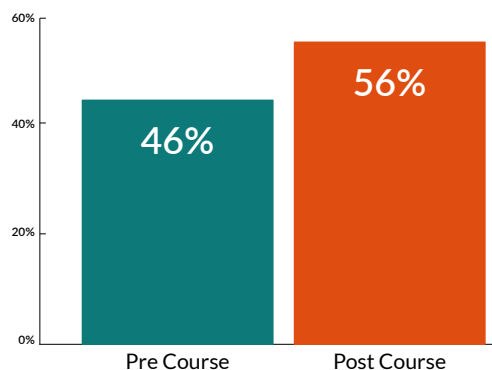

FREQUENCY OF EXTENDED CONVERSATIONS

PHONOLOGICAL SKILL IMPROVEMENT

PERCENT OF PARTICIPANTS WHO POSSESSED ALL THE PHONOLOGICAL AWARENESS SKILLS MEASURED

ALPHABET AND PHONICS SKILL IMPROVEMENT

PERCENT OF PARTICIPANTS WHO POSSESSED ALL THE ALPHABET AND PHONICS SKILLS MEASURED

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Sentence Structure Complexity and Variety

The percentage of participants who often or very often used a great variety of sentence structures increased from 40% in the pre-course survey to 59% in the post-course survey. Skill improvement here was greater when parents taught their children how to read words and letters more often and provided more books in the home.
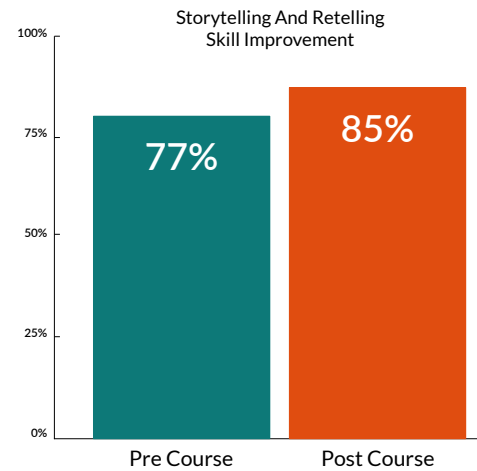
Storytelling & Retelling (STR)

The percentage of participants who could often or very often tell or retell a story increased from 77% in the pre-course survey to 85% in the post-course survey. Greater skill improvement from pre- to post-survey was associated with parents who read stories to their children more often and had more books available for children to read at home.
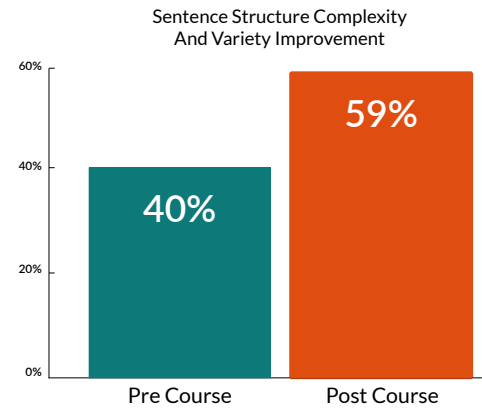
Qualitative Feedback from Parents

Three parents were interviewed about their experience with WORD Force. Overall, parents said their children had a positive experience with WORD Force, and responded that it was fun, engaging, and that the difficulty of the games was just right. Parents thought the "consonant-vowel-consonant (CVC)" game, the "beginning, middle, ending sounds" game, and the "rhyming" game were most beneficial for their children. One parent noted that being able to switch between games when stuck and allowing children to redo games without going backwards in the game helped with their self esteem. Another parent also noticed that their child was more confident in their own literacy skills after playing WORD Force. Although parents noted some minor technical difficulties with the platform, it did not negatively affect their children's experience.
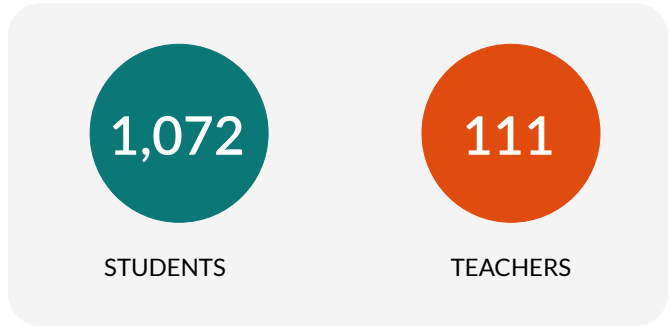
Sentence Structure Complexity And Variety Improvement

Pre Course: 40%
Post Course: 59%

Percent Of Participants Who Often Or Very Often Used A Great Variety Of Sentence Structures

Storytelling And Retelling Skill Improvement

Pre Course: 77%
Post Course: 85%

Percent Of Participants Who Can Often Or Very Often Tell Or Retell A Story
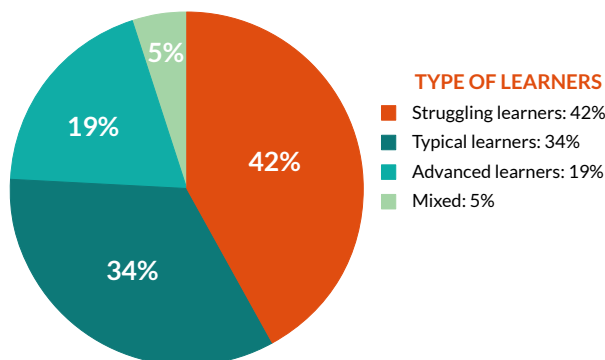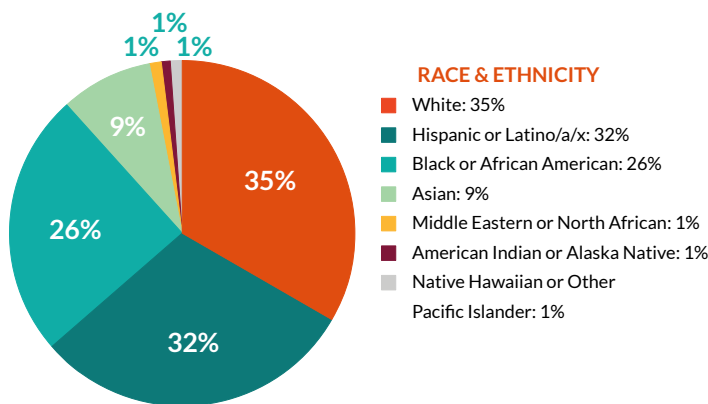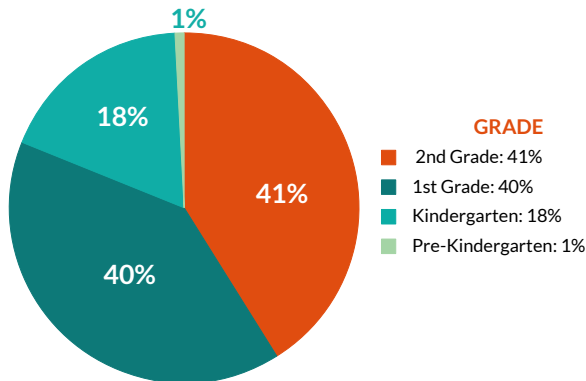
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The Classroom Study

The Classroom Study focused on the improvement of students' early literacy skills as they used the course at school. To evaluate if the participants' skills were significantly improved after they use the course, a linear mixed model was created with the pre-course skill score, student characteristics, teacher characteristics, and classroom literacy environment added as control variables. To reveal what factors could influence the skill improvement, another regression analysis of the participants' skill improvement on the teacher characteristics, student characteristics, and the classroom literacy environment was also conducted using the linear mixed model method.

Classroom Sample Demographics

1,072 STUDENTS

111 TEACHERS

English Language Learners (ELL) (21%)

Students

GRADE
- 2nd Grade: 41%
- 1st Grade: 40%
- Kindergarten: 18%
- Pre-Kindergarten: 1%

RACE & ETHNICITY
- White: 35%
- Hispanic or Latino/a/x: 32%
- Black or African American: 26%
- Asian: 9%
- Middle Eastern or North African: 1%
- American Indian or Alaska Native: 1%
- Native Hawaiian or Other Pacific Islander: 1%

TYPE OF LEARNERS
- Struggling learners: 42%
- Typical learners: 34%
- Advanced learners: 19%
- Mixed: 5%

Teachers

Teaching experience

- 5 years or less (15%)
- 6-10 years (22%)
- 11-15 years (17%)
- 16 years or more (45%)

Early literacy skill (ELS) teaching experience:

- 5 years or less (24%)
- 6-10 years (23%)
- 11-15 years (13%)
- 16 years or more (40%)

Teachers with early literacy teaching training: 94%

Confidence in teaching phonological awareness skills to:

- Typical learners: Confident / Very Confident 96%
- Struggling learners: Confident / Very Confident 86%
- Advanced learners: Confident / Very Confident 90%
- English learners: Confident / Very Confident 72%

Confidence in teaching phonics skills to:

- Typical learners: Very Confident 94%
- Struggling learners: Very Confident 87%
- Advanced learners: Very Confident 89%
- English learners: Very Confident 68%

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Student Characteristics

In general, students in kindergarten, 1st, and 2nd grade had higher levels of early literacy skills than those in pre-kindergarten (table below).

	Phonological Awareness	Phonics	Spoken Language
Pre-Kindergarten	34/100	65/100	2.1/5
Kindergarten	42/100	76/100	3.7/5
First Grade	58/100	80/100	3.8/5
Second Grade	65/100	80/100	3.8/5

In general, we also found that students classified as White had higher baseline skill levels in both phonological awareness and spoken language than their peers. Students who were English language learners had lower baseline scores on all three skill sets, as did students labeled as struggling. While these findings are interesting, they will not impact the sample of students we recruit for our efficacy study as we are still focused on gauging the impact of WORD Force on the most heterogeneous sample available.

## Classroom Literacy Environment and Teacher Characteristics

After controlling for the teacher characteristics, the association between classroom literacy environment and the students' baseline early literacy skills became insignificant. Our analysis shows that teachers' teaching experience likely had a significant impact on the number of books in the classroom, how the teachers managed the access to the books, and the use of literacy blocks. Teachers with more years of experience teaching early literacy skills were more likely to give students free access to   the books in the class and use literacy blocks in their teaching.

Skill Improvement

Overall, after students used WORD Force, we observed a significant improvement in all the three early literacy skills we measured (phonological awareness, phonics and spoken language skills). Overall, significant improvement in the post-course survey was observed for struggling and typical learners but not for advanced learners. Struggling learners had greater improvement than typical learners did, although the difference was not specifically significant. The following analysis reveals more nuanced changes in the students' skills.

Phonological Awareness
The average phonological awareness score improved by 29% from 56/100 in the pre-course survey to 72/100 in the post-course survey. The impact of student characteristics and classroom literacy environment varied depending on whether the students were typical or struggling learners (figure below).

PHONOLOGICAL AWARENESS SKILL IMPROVEMENT

Legend: ■ Phonological Awareness - Pre Score ■ Phonological Awareness - Post Score
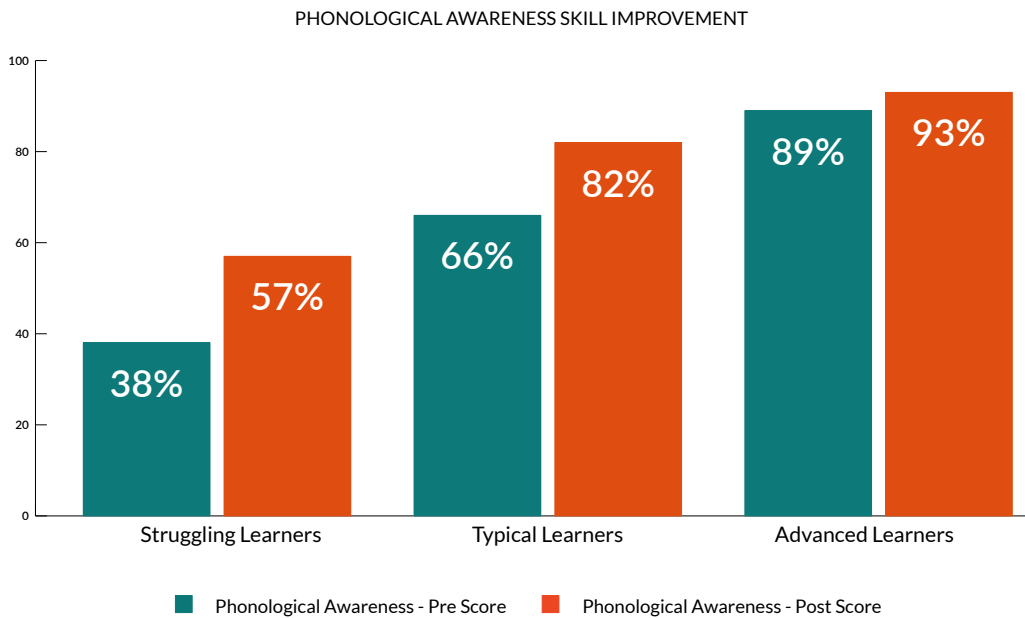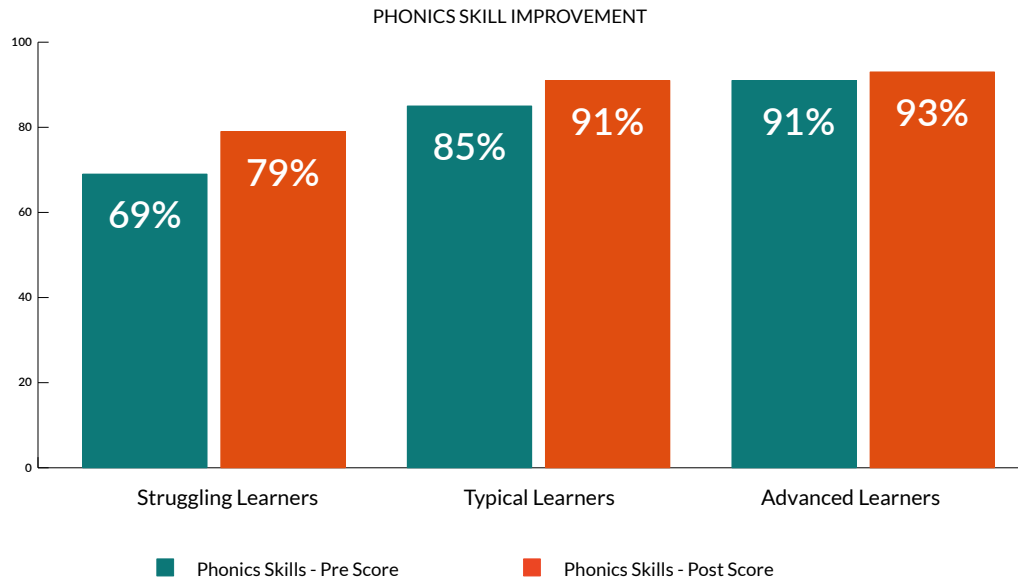
Struggling learners saw greater improvement when their teachers had received early literacy skills training when they were in smaller classes. In regard to the literacy block in class, struggling learners thrived when teachers included small group instruction, one-on-one instruction, peer work, and independent work. As seen in the figure, for typical learners, their skill improvement was the largest for students in kindergarten, but the smallest for students in the second grade. Similarly, the improvement among the typical learners was greater if their teachers received training on how to teach early literacy skills.

SKILL IMPROVEMENT BY GRADE

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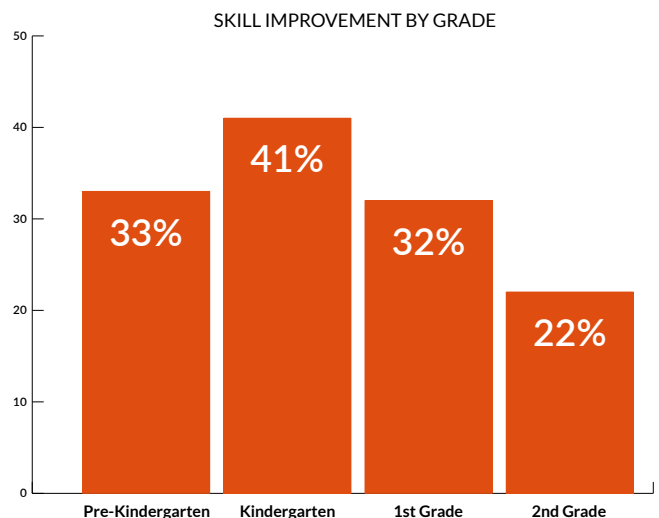
Phonics

The average phonics score improved by 10% from 78/100 in the pre-course survey to 86/100 in the post-course survey. The impact of student characteristics and classroom literacy environment varied depending on whether the students were typical or struggling learners (figure below).

PHONICS SKILL IMPROVEMENT

Legend: ■ Phonics Skills - Pre Score   ■ Phonics Skills - Post Score

As with phonological awareness, struggling learners saw greater improvement when their class size was smaller (figure below), their teachers had received early literacy skills training and when their teachers included a variety of instructional strategies in their literacy blocks. Typical learners in the second grade saw the least improvement in their early literacy skills compared to their peers. Also, typical learners with teachers who had more years of experience teaching early literacy skills showed greater improvement.

SKILL IMPROVEMENT BY CLASS SIZE

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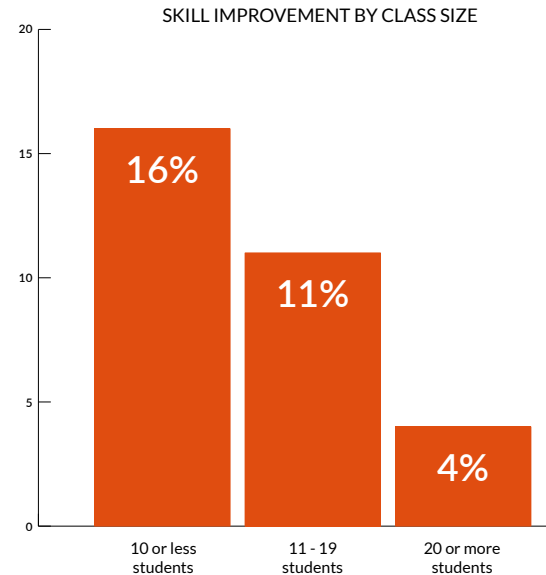
Spoken Language Skills

The percentage of students who often or very often displayed age-appropriate spoken language skills increased from 52% in the pre-course survey to 68% in the post-course survey. Similarly, our analysis showed that the impact of student characteristics and classroom literacy environment varied depending on whether the students were typical or struggling learners (figure below).

SPOKEN LANGUAGE SKILL IMPROVEMENT

- Spoken Language Skills - Pre Score
- Spoken Language Skills - Post Score
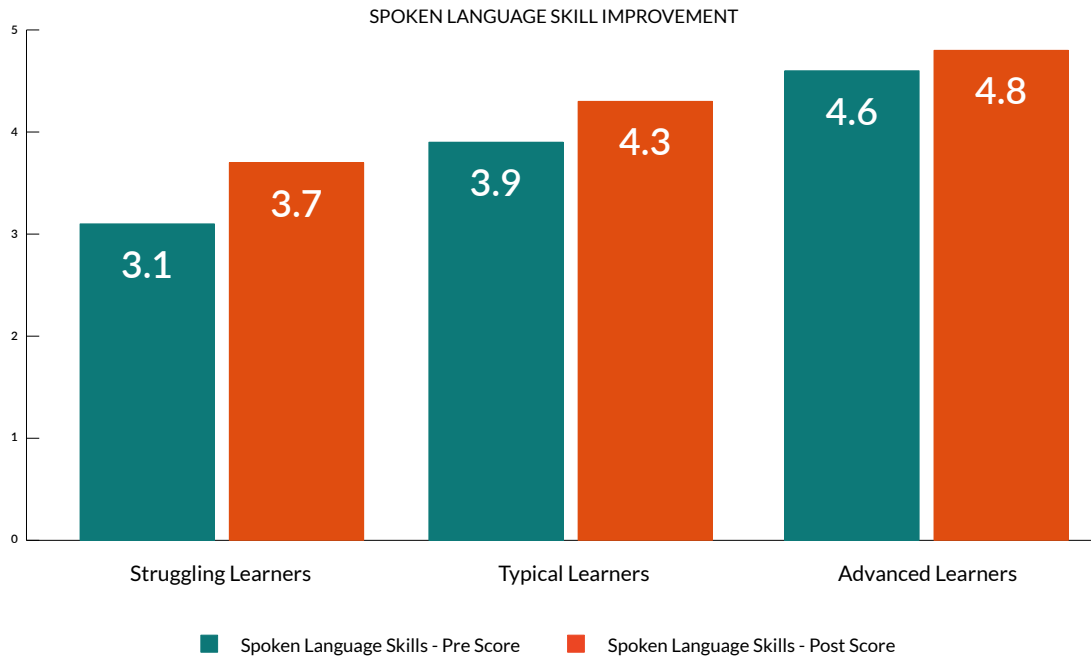
As with the struggling learners in previous sections, greater improvement was seen for students when the teachers employed small group instruction, one-on-one instruction, peer work and independent work in their literacy block. Greater improvement was also observed for the struggling learners in smaller classes. For typical learners, the students in higher grades tended to have greater improvement in their spoken language skills. Unlike struggling learners, typical learners achieved greater improvement in classes with more students. The students whose teachers had more years of experience teaching early literacy skills showed greater improvement (figure below). For both typical and struggling learners, the improvement was greater if their teacher received training in teaching early literacy skills.

SKILL IMPROVEMENT BY ELS TEACHING EXPERIENCE

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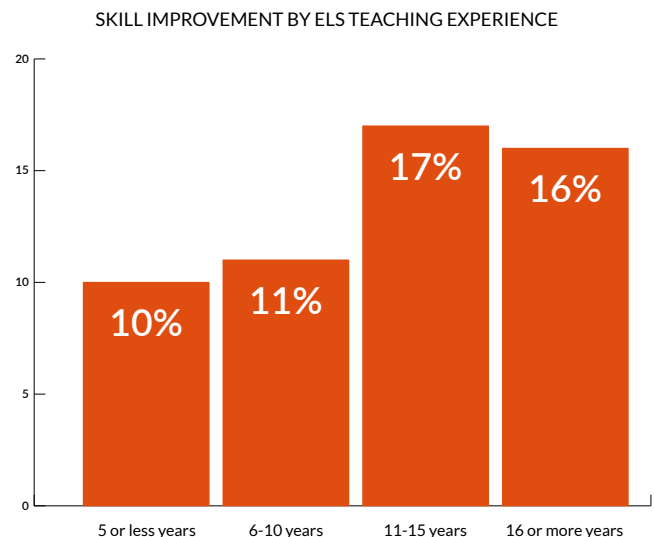
Qualitative Feedback from Teachers

Three teachers were interviewed about their experience with WORD Force in their classroom. In general, teachers agreed that the difficulty of the content was about right for the average student. While struggling learners found it hard, advanced learners found the first few levels overly easy. Teachers found the rhyming games to be the most beneficial for their students. They also reported that students who struggled with the sounds "ee" like in "beet," "a" like in "cat," and "ay" like in "way" were better able to differentiate words with those sounds after playing the games. Teachers also noted that they found the pre- and post-test assessments beneficial, as they could see where students were struggling and give students more support in those areas. Teachers did experience some minor technical difficulties but they did not interfere with the overall experience. Compared to other literacy programs, teachers found WORD Force to be more engaging and fun for students.

Post Hoc Comparison Group Analysis

Although we required that all participants of the study complete at least three WORD Force games to receive compensation for their participation, there were 28 students who did not play any games during the study period. Since the teachers of these 28 students still evaluated their early literacy skills in the pre-course and post-game surveys, these 28 students were employed as a control group of convenience. We compared the skill improvement of students who played at least three games with these students who had no activity. After controlling for the influence of student demographics, teacher characteristics, and classroom literacy environment, a significant difference in early literacy skill change was found. While the phonological awareness, phonics and spoken language skills of the students who played at least three games significantly improved after they played the games, there was no significant skill change for students with no activity.

While it may be tempting to suggest that the positive effect of WORD Force we found on students was not due to the "natural maturation" of the students, it must be pointed out that the observational study is not designed in a rigorous enough manner to derive that conclusion. Compared to the students who played at least three games, the 28 students in the "control group" had very different demographic features and were taught by teachers with very different characteristics. Therefore, these 28 students are not an adequate comparison group for the other students who engaged with WORD Force. Thus, a more rigorous efficacy analysis with a randomized control experimental design is necessitated and will be conducted in Fall 2023 by EVERFI.

Conclusion

We consider our observational research phase on the WORD Force course to be successful for a number of reasons. First, the User Behavior Analysis showed that, in all games, students did improve in their assessments scores comparing pre-to post-game data. This analysis also found that learners who played more games and played consistently saw greater improvement in their pre- to post-assessment scores.

Second, the Family Study revealed that parental perceptions of a child's early literacy skills increased in direction with our assessment score gains, providing some validity for those measures. Also, children in homes with more books and more interactive parents gained more from their WORD Force experience than their peers.

Finally, the Classroom Study further provided validity to our assessment measures as teacher evaluations of learner skills were also correlated with gains found in the course and students who required additional support in the classroom benefited the most from their interactions with WORD Force. Further, students in highly stimulating classroom environments with trained and engaged teachers showed the greatest gains.

While these findings are encouraging, because subjects were not randomly assigned to treatment groups, no definitive causal inferences about the impact of WORD Force can be made at this time. As suggested by the phased research approach (Fey, 2014; Robey, 2004), the next step in determining the efficacy of our program will require a randomized controlled trial (RCT) design. Our results here will be used to develop a more rigorous framework for evaluating WORD Force ensuring that we include students most likely to gain early literacy skills from the interaction and to improve our measurements where we see fit.

Findings from this phase of research will inform a final leg of observational research in the school year 2022-2023 on an updated version of WORD Force. Analysis of all observational findings will establish a very solid foundation for building the school year 2023-2024 efficacy study, which will be the highest level of evidence (i.e., RCT) for determining the effectiveness of our early literacy program.

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Appendix

Operational Definitions[5]

Phonological Awareness is an umbrella term that refers to the awareness of the sound structure in spoken words at the word, syllable, rhyme, and phoneme levels (e.g., onset-rime awareness, phonemic awareness).

- **Onset-Rime Awareness** is a phonological awareness component in which there is an awareness of the onset (initial phoneme in a syllable) and the rime (the vowel phoneme and any subsequent consonant sounds) in a syllable. For example, the onset for the one syllable word "team" is /t/ and the rime is /im/.

- **Phonemic Awareness** is the most advanced form of phonological awareness in which an awareness and ability to manipulate the individual speech sounds in spoken words (i.e., **phonemes**) is present. For example, there are three phonemes in the word "team": /t/, /i/, /m/.

Phonics is the ability to read and spell words due to the knowledge that printed alphabet letters (and their combinations) represent individual speech sounds (i.e., **phonemes**).

Spoken Language is a two component skill: the ability to understand information communicated verbally and the ability to clearly and accurately express thoughts verbally to others. A few spoken language subskills captured in the family survey follow:

- **Speech Sound Production** is a component of articulation and phonology together which is the ability to form and verbally produce the individual speech sounds that make up spoken words in a language.

- **Sentence Structure Complexity and Variety** is a component of syntax and pertains to the ability to produce sentences that vary in length and complexity (e.g., number and type of clauses, use of advanced vocabulary).

- **Grammar** is a component of morphology and syntax and signals awareness of the ways in which affixes (i.e., prefixes like "un" on "unlike" and suffixes like "er" on "runner") can change the tense and meaning of individual words and words in the context of sentences.

- **Vocabulary Learning** is a component of semantics and it reflects the degree of knowledge of a variety of words and the ways in which they can be used in language.

- **Storytelling and Retelling** allows the use of all parts of language (i.e., phonology, semantics, morphology, syntax, and pragmatics) to convey thoughts in an ordered and clear fashion.

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[5] For more information on these topics, see the National Reading Panel (2000) report, which is cited in our references.

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Early Literacy Skills Crosswalk

Skills	Course Assessments	Family Study Survey	Classroom Study Survey
Phonological Awareness			
Rhyming	Raise-a-Rhyme	x	x
Onset-Rime	Sprouting Sounds	x	x
Phonemic Awareness	Sprouting Sounds & Cotton Candy Breakdown	x	x
Phonics			
Letter-Sound Association	Veggie Village	x	x
Spelling	Stellar Speller, Icy Letter Ladders Littered Lagoon, Robot Recycler & Wandering Words		x (as part of the phonics skill measurement)
Reading Vocabulary	Conserve-a-Word & Dictionary Dig		
Reading Comprehension			
Reading Comprehension (Grammar)	Suffix Summit	x (as part of the spoken language skill measurement)	x (as part of the broad spoken language skill measurement)
Reading Comprehension (Vocabulary)	Word Force Adventures, Sea Stories & Solar Sentences	x (as part of the spoken language skill measurement)	
Spoken Language			
Vocabulary Learning		x (as part of the phonics and spoken skill measurement)	x
Sentence Structure Complexity and Variety		x	
Speech Sound Production		x	
Storytelling & Retelling		x	
Interest in Reading/ Reading-Like Activities			
Interest in Words		x	
Interest in Books		x	

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