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AT CHARLES RIVER MEDIA

Lexercise Efficacy Report

Grades 2-6, 2023-2024

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DECEMBER, 2024

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PROMISING

LXD Research Recognition for Lexercise

Lexercise®

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 3** for "**Promising**." 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

December 5, 2024

DATE

Understanding ESSA Evidence

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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 determines 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 3:

- In correlational design, students who used the program are compared to normed referenced samples or other group averages for comparison.
- Multiple studies with the proper design and implementation with at least two teachers and 30 students show statistically significant, positive findings.
- The study uses a program implementation that could be replicated.
- A third-party research organization has reviewed the documentation for ESSA validation.

When product designers leverage learning sciences to design and evaluate their programs, educators can better target instruction, and students' skills soar. Through a correlational study design, a statistical evaluation shows that student growth is associated with student product use. This product meets the criteria for LXD Research's ESSA Tier 3 Evidence.

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

EFFICACY STUDY SUMMARY
GRADES 2-6
2023-2024

Lexercise®

PROGRAM DESCRIPTION

Lexercise is a literacy platform with structured instructor-led literacy lessons and engaging online independent student practice to support learning in the classroom, in therapeutic settings, and at home. The program consists of 44 lessons organized into 26 levels, focusing on sounds and letters, decoding and spelling, definition building, word parts, comprehension, and sentence reading, and writing.

STUDY DETAILS

Sample Description

- 198 students in grades 2-6
- Receiving reading intervention services through Lexercise
- Started program before 3/1/2024
- At least 3 total months of use

Time Frame

August 1, 2023 - June 30, 2024

Implementation Description

- Weekly individual therapy sessions
- Recommended four 15-min practice sessions weekly
- Adaptive weekly Decoding Assessment

Methodology

- Correlation and regression for progress, usage and mastery
- Random forest analysis and decision tree for key factors related to mastery
- Cluster analysis for identification of distinct learning profiles

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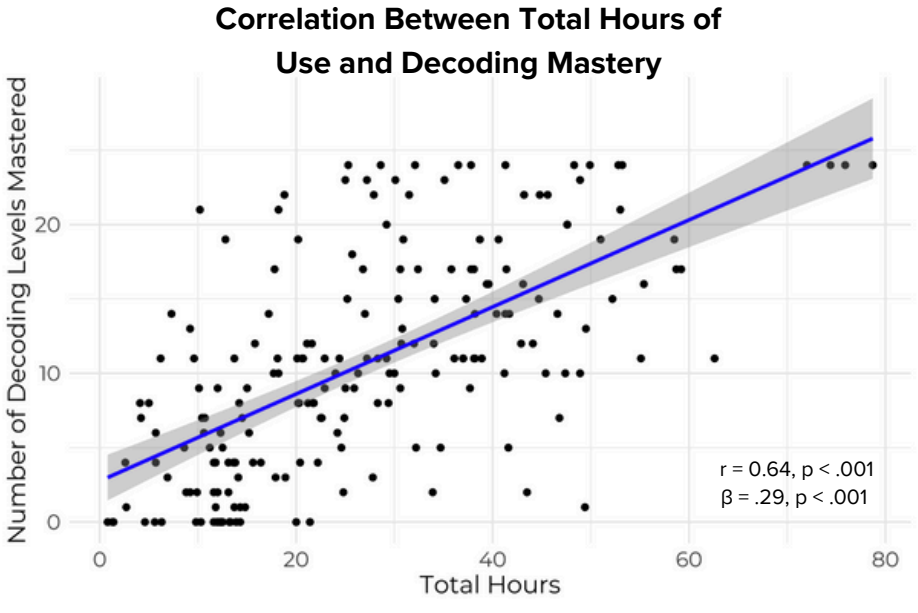
STUDY CONTEXT

Lexercise hired LXD Research to evaluate the impact of Lexercise on decoding skill progress and mastery. Students participated in weekly 45-min synchronous reading intervention sessions followed by a recommended three to four 15-min independent student practice sessions per week. LXD Research analyzed students' Lexercise Lesson Level Progression and their performance on a built-in Decoding Assessment across 2023-2024.

KEY FINDINGS

- Students used the program with **close adherence** to the prescribed intervention model.
- The Decoding Assessment **worked exactly as designed**, balancing easy, moderate, and difficult items.
- Total hours of usage was linked to greater decoding mastery, indicating an **importance of consistent usage**.
- Number of levels completed was linked to greater decoding mastery, indicating that students were making **genuine skill progress** from the lessons.
- Three distinct learner profiles were identified, suggesting **differences in how learners engaged** with the app and the resulting impact on their mastery.

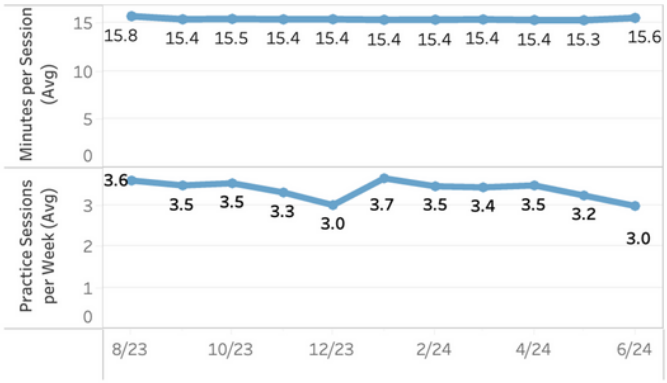
More usage of Lexercise was related to greater decoding mastery.



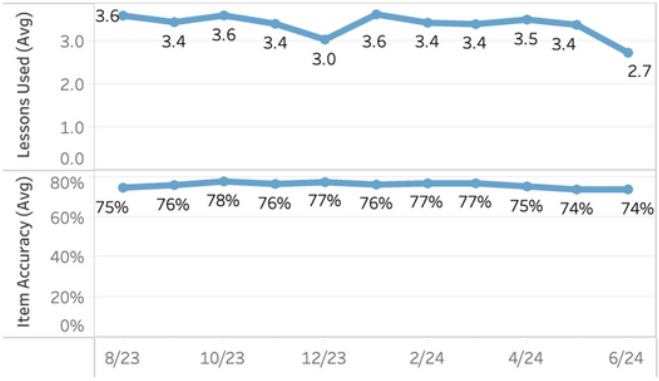
CONSISTENCY OF STUDENT USAGE

Students used Lexercise with strong adherence to the prescribed intervention model, averaging 15 minutes per practice session and 3 to 4 sessions per week, with expected slight dips in December and June. Student lesson completion averaged 3-4 lessons per month, maintaining the intended pace of instruction.

Avg Minutes Per Practice Session & Number of Sessions Per Month



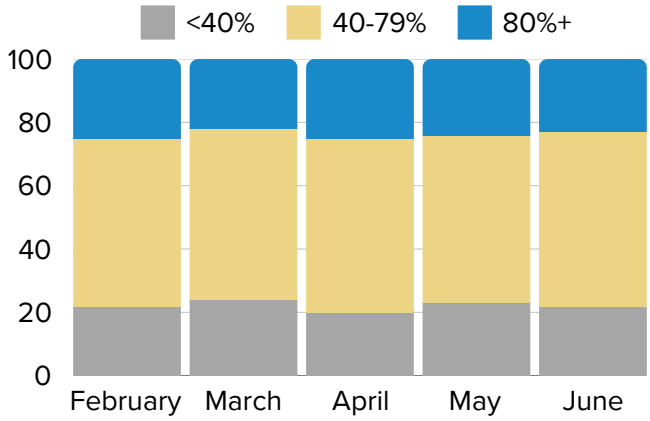
Avg Number of Lessons & Item Accuracy Per Month



BALANCED ASSESSMENT DESIGN

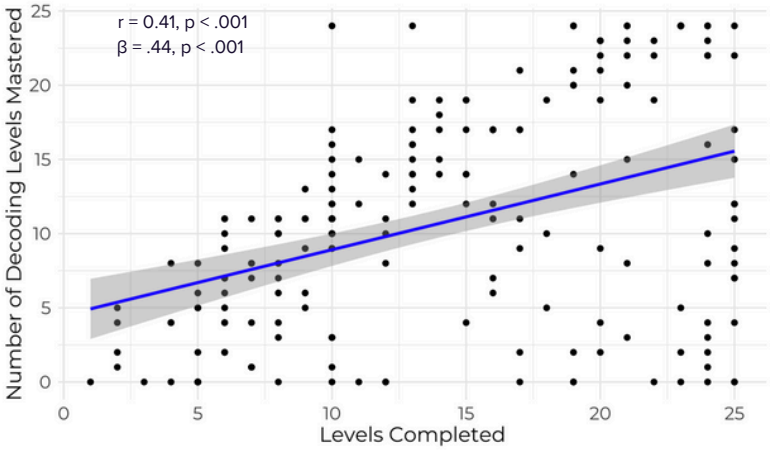
The 10-item adaptive decoding assessment included a balanced set of items based on difficulty level. Approximately 20-25% of items resulted in low (<40%) or high accuracy (80%+) performance, with most items in the medium range (40-79%). This distribution suggests the assessment successfully maintained an optimal challenge level while providing necessary practice opportunities for difficult concepts. The dynamic adjustment of test items based on student performance functioned as designed, effectively tracking skill development.

Decoding Assessment Performance by Month



GENUINE SKILL PROGRESS

Correlation Between Lessons Completed and Decoding Mastery

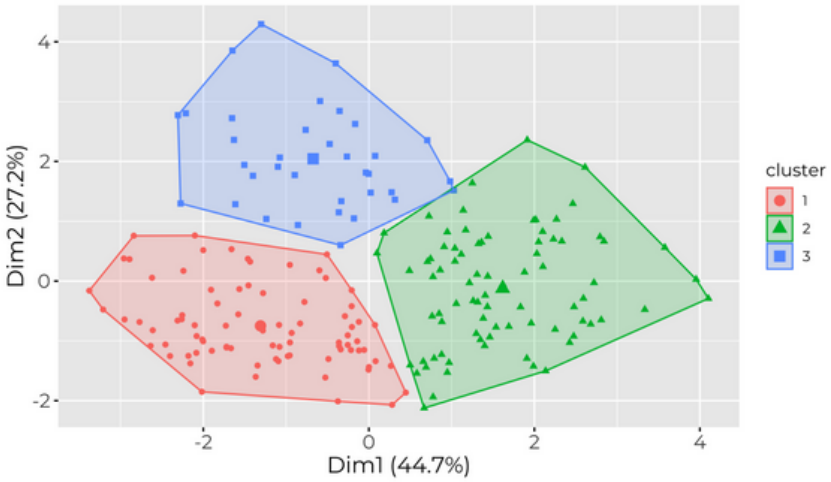


The number of Lexercise Lesson Levels completed since enrollment and students' decoding mastery were positively correlated, suggesting that progressing through the program levels is closely associated with improved decoding concept know-ledge. This indicates that students benefited from sustained usage, and cannot easily 'game' the Lexercise system without building genuine skill development.

DISTINCT LEARNER PROFILES

Three distinct learner profiles were identified through k-means cluster analysis: **Early Learners**, **Consistent Progressors**, and **Complex Learners**. These profiles represent distinct patterns of Lexercise usage and resulting decoding mastery. Students matching the 3 different profiles differed significantly from one another in their length of enrollment, consistency of program usage, and overall achievement in terms of decoding mastery.

Distinct Learner Profiles via Cluster Analysis



Characteristics of Each Learner Profile

Characteristics		Learner Profiles		
		Early Learners (n = 82)	**Consistent Progressors (n = 81)**	**Complex Learners (n = 35)**
Enrollment	**Most Common Grade Level in 23-24**	Grades 2-3	Grades 3-5	Grades 3-6
	Baseline Level in 23-24	Low (M = Level 2)	Moderate (M = Level 6)	High (M = Level 11)
	Total Months of Enrollment	Less than a year (M = 11 months)	About two years (M = 22 months)	Over two years (M = 29 months)
Program Usage	**Hours of Use in 23-24**	Half prescribed time (M = 20 hours)	Exactly as prescribed (M = 40 hours)	Less than half prescribed time (M = 15 hours)
	Months of Use in 23-24	Half the year (M = 6 Months)	Nearly all year (M = 10 Months)	Half the year (M = 6 Months)
Achievement	**Decoding Levels Mastered in 23-24**	Moderate (M = 7 Levels)	High (M = 18 Levels)	Low (M = 4 Levels)
	Level Completion since Enrollment	Moderate (M = 8 Levels)	High (M = 17 Levels)	High (M = 21 Levels)

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The Impact of Lexercise on Student Skill Progress and Mastery

Examining the effect of one year of structured literacy intervention on student decoding skill progress and mastery

Prepared by Rachel L. Schechter, Maddie Lee Mason, & Laura Janakiefski
LXD Research

Abstract

This study examines the usage and effectiveness of Lexercise, a hybrid reading intervention program combining weekly literacy intervention with structured independent practice, in supporting reading skill development among struggling readers. Analysis of 198 students in grades 2-6 during the 2023-2024 school year revealed strong adherence to the prescribed intervention model of weekly 45-minute structured literacy lessons supplemented by four 15-minute independent practice sessions. Results showed a significant positive correlation between total program time and decoding mastery ($r = 0.64$, $p < .001$), with optimal outcomes observed at 24 and 33 weeks of consistent usage. A random forest analysis identified total hours spent, months of program use, and levels completed as the strongest predictors of decoding mastery. Cluster analysis revealed three distinct learner profiles: Early Learners (younger students with moderate usage), Consistent Progressors (older students with high adherence and strong mastery), and Complex Learners (students with high-level completion but limited mastery). While younger students progressed more quickly through program levels, older students required additional time for mastery, particularly at higher levels. These findings suggest that structured, technology-enhanced reading intervention can effectively support reading skill development when implemented with fidelity, though implementation strategies may need adjustment based on learner profiles.

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Introduction

Problem of Practice

The literacy crisis in American education continues to deepen, with recent data indicating that reading recovery from pandemic-related learning losses remains significantly behind expected trajectories (Lewis & Kuhfeld, 2024). Of particular concern is the growing population of older students who struggle with fundamental reading skills, with approximately 20% of late elementary and middle school students reading below basic proficiency levels (Shapiro et al., 2024; Wang et al., 2024; The 74 Million, 2024). Despite the clear need for intensive support, there are not enough reading specialists in secondary schools to meet this demand (NCES, 2023; EdWeek, 2022; USA Today, 2024). This shortage of specialized instruction is particularly problematic, given that opportunities for deliberate practice are perhaps the most important elements in overcoming reading difficulties (Vaughn & Fletcher, 2021).

Given the combination of high costs and limited availability of qualified professionals to deliver one-on-one professional reading therapy, struggling readers often face substantial barriers to accessing effective and targeted reading intervention. Digital learning interventions have emerged as a promising solution, demonstrating positive impacts on both cognitive learning outcomes and student motivation (Barz et al., 2023). Modern technology platforms can effectively deliver systematic, explicit instruction while incorporating research-based multimedia learning principles that engage students without creating cognitive overload (Mayer & Fiorella, 2021).

Lexercise is one such tool addressing these challenges through a hybrid model, combining weekly reading intervention lessons with independent student practice on a digital app. Built on the Simple View of Reading framework (Hoover & Tunmer, 2020), the platform implements a high-dosage, cumulative intervention intensity approach (Cordella & Kiran, 2024). In Lexercise, students receive one weekly lesson with a reading specialist, complemented by four 15-minute independent practice sessions using computer-adaptive instruction and activities. This model maximizes the impact of limited professional resources while ensuring students receive the consistent, targeted practice necessary for skill development.

The present study examines the effectiveness of this hybrid approach in supporting reading progress across diverse student populations and baseline ability levels. By analyzing the relationship between practice time, completed activities, and reading gains, this research aims to understand how technology-enhanced intervention can help close persistent literacy gaps. Of particular interest is understanding the platform's ability to support students who are significantly below grade level and whether student characteristics influence intervention outcomes.

Lexercise Approach to Teaching Reading

Lexercise is a program designed to be used with a reading specialist or other qualified professional, combining weekly structured lessons in a private session with consistent independent practice. Students participate once a week in an in-person or synchronous online intervention session completing the Lexercise lessons and then practice independently via computer adaptive instruction.

Lexercise lessons can be delivered through three implementation formats: Professional Therapy, Basic Therapy, or Lexercise for Schools. Professional Therapy involves synchronous lesson delivery with a structured literacy specialist, whereas the Basic Therapy and Lexercise for Schools options offer pre-recorded expert instruction that can be used to support lesson delivery and ensure program fidelity. In both formats, lessons are interactive rather than passive, where students engage in ongoing dialogue through guided prompts that address key domains of the English language: phonemic awareness and phonics, orthography, morphology, semantics, syntax, comprehension, and writing.

Following each lesson, students complete 4 days of 15-minute independent student practice designed to reinforce concepts and build automaticity. Each 15-minute practice session delivers approximately 60 response challenges, maximizing engagement through deliberate practice (Dehaene, 2020; Koedinger et al., 2023). The platform employs multimedia learning principles that maintain student engagement while minimizing distracting elements (Mayer & Fiorella, 2021), using coordinated audio and visual features to direct attention to relevant information and support retention (Dehaene, 2020). Students also receive immediate feedback on their responses, with opportunities for retry and correction, along with explicit explanations both before activities and in response to errors (Wisniewski et al., 2020).

Progress through the Lexercise curriculum is carefully structured, with students typically beginning between Level 1 and Level 4 based on grade level and assessment data. Lexercise recommends advancing students to subsequent lessons when they achieve approximately 70% accuracy within a given Lexercise Level, with detailed practice data available to instructors at the item level for monitoring error patterns. This systematic approach, organized around seven integrated stations that bridge word-level and text-level skills, ensures comprehensive coverage of literacy components while maintaining their interconnected nature (Hoover & Tunmer, 2020; Lonigan et al., 2018; Blachman et al., 2019).

The Lexercise platform also includes built-in screening and progress monitoring tools, allowing educators to make data-driven adjustments to tailor instruction to individual student needs. Nonsense word reading assessments are common and reliable ways to monitor decoding skills and concept knowledge (Harm & Seidenberg, 1999; Steacy et al., 2021; Edwards et al., 2023). However, traditional decoding assessments often need to be administered individually by a

trained professional in real-time. An automated decoding assessment that produces results similar to traditionally administered assessments provides a major benefit by being an asynchronous way to gauge skill progression. In a previous study looking at a traditional synchronous assessment format administered by a trained professional compared to the Lexercise online decoding assessment format, there was no difference in students' accuracy across the two measures, indicating that the two assessment formats track student skill similarly (Barrie Blackley & Morris., 2023). The results of the previous work suggest the utility of the Lexercise online assessment for monitoring decoding accuracy. The current study builds on these findings by exploring how students engaged with and progressed through the Lexercise Lessons and Decoding Assessment and how the use of the assessment aligns with the intended design. The study also investigates how individual student use of the Lexercise program and learner profiles impacted the students' decoding skills and concept knowledge, as reflected by their progression through the program levels and their performance on the Decoding Assessment.

Research Questions

Student Usage and Assessment Design

1. Do students adhere to the recommended usage of the Lexercise program?
2. Is the decoding assessment adapting to student performance as intended?

Factors Related to Decoding Mastery

3. What are the key factors associated with decoding mastery in the Lexercise program during 2023-2024?
    a. How do these factors interact to determine student outcomes?
    b. Is there an optimal amount of program use that maximizes decoding mastery?
4. To what extent do additional time and progress (levels completed) within Lexercise provide the necessary support for student decoding mastery?

Distinct Learner Profiles

5. Are specific student characteristics (i.e., baseline ability, grade level) or usage patterns associated with different rates of progress or decoding mastery?

Methods

Study Design and Timeline

This study examined student progress data from individual lessons using the Lexercise platform. The study period spanned from August 1, 2023, to June 30, 2024, with participants required to

have initiated program use before March 1, 2024, and completed at least three months of intervention (not necessarily consecutive).

Participants

The sample consisted of 198 students in grades 2-6 who received private reading intervention services through Lexercise with reading specialists, Structured Literacy Dyslexia Specialists, or other qualified professionals. All participants worked within Levels 1-10 of the curriculum at some point during the study period. 106 students in the sample were male, and 92 students were female. During the 2023-2024 school year, 53 students were in Grade 2, 62 in Grade 3, 36 in Grade 4, 31 in Grade 5, and 16 in Grade 6.

Program Implementation

Students participated in weekly 45-minute synchronous lessons with their assigned intervention specialist, followed by independent practice sessions. The recommended practice schedule included four 15-minute sessions per week using the platform's computer-adaptive instruction system. During each independent practice session, students completed approximately 60 response challenges focused on recently introduced concepts.

Outcome Measures

Two primary measures were used to assess student progress: Lexercise Lesson Level Progression and a Decoding Assessment. Both outcomes are built into the Lexercise program. Table 1 lists all key outcome variables analyzed in the current study.

Lexercise Lesson Level Completion

One measure of student progress was the number of Lexercise levels completed since their initial enrollment. There are 26 levels and 44 lessons in the Lexercise curriculum. Each lesson follows a 7-station sequence that begins with phonemic awareness and ends with sentence-focused comprehension and writing. Each lesson includes a set of new concepts (i.e., objectives) explicitly explained and then practiced along with previously introduced concepts in a gradual release of responsibility format. Content is designed so that interventionists will typically cover one to three sets of new concepts in each 45-minute weekly lesson, followed by practice. For example, an interventionist teaches Level 5, Lesson 1 on Tuesday, which covers three groups of concepts: 1) f,l,s,z doubling pattern (as in *cuff, bell, kiss, buzz*), 2) new suffixes: -less, -ness, and 3) new Sight Words: who, what, when, where, why, which, how. Then over the next six days (Wednesday – Monday), the student's practice will be focused on those three groups of Level 5, Lesson 1 concepts while also spiraling previous material.

Decoding Assessment

A second measure of student progress was performance on the Lexercise decoding assessment. Each week, as part of their independent practice, students get a 10-item decoding challenge covering concepts from previously taught lessons. Students need 80% accuracy on all items at a given level to achieve decoding mastery at that level. Assessment items are drawn from both the current instruction level and any unmastered lower levels. The assessment is adaptive, such that successfully mastered items are removed from the pool, and items from newly introduced concepts are added in their place. Students who demonstrate incomplete mastery of lower-level concepts continue to receive practice on those items until reaching 80% accuracy. For example, if a student was just taught a lesson at Level 5 and has 60% accuracy at Level 3 but 80% at Level 4, their challenge for the current week would include a mix of items from Level 3 and Level 5. The assessment was launched in January 2024 and started at the first level's concepts, about mid-way through the year covered in this study. The number of levels in which decoding concepts were mastered according to the decoding assessment served as a primary measure of achievement in this study.

Table 1. Overview of Key Variables

	Variable Name	Definition
Enrollment	Grade Level	Student's grade level (2nd to 6th) at the start of 2023-2024
	Baseline Level	Student's Lexercise Level at the start of 2023-2024
	Total Months of Enrollment	Number of months the student had been enrolled in Lexercise
Program Usage	Number of Practice Sessions	Number of unique practice sessions/days of use during 2023-2024
	Practice Session Duration	Average length of individual practice session in minutes
	Hours of Program Use	Hours spent using Lexercise during 2023-2024
	Months of Program Use	Number of months of Lexercise use during 2023-2024
Achievement	Level Completion since Enrollment	Number of Lexercise Levels (lessons) completed since enrollment
	Decoding Mastery	Number of levels mastered in the Decoding Assessment throughout 2023-2024
	Decoding Accuracy	Average accuracy of Decoding Assessment items throughout 2023-2024

Analysis Plan

Students' Lexercise usage was explored descriptively to determine how closely students followed the prescribed Lexercise guidelines (i.e., 15-minute independent practice sessions at least 4 days per week). Similarly, to evaluate Lexercise's adaptive decoding assessment launched in January 2024, descriptive analyses were conducted to assess how well the assessment adjusts to each student's performance. This includes examining the percentage of items answered with low, medium, and high accuracy, as well as how these patterns align with the program's design for adaptive practice.

To investigate how the Lexercise program usage and level completion through the program relate to students' decoding mastery, the strength of these associations was analyzed using correlation and regression techniques. A decision tree was also performed to identify the specific aspects of student usage and level completion that most strongly predict the number of levels mastered in the decoding assessment. This decision tree offers a visual overview of how the usage of the Lexercise program influences decoding mastery. Additionally, a follow-up analysis was conducted to isolate the specific impact on mastery of hours using Lexercise in 2023-2024 by controlling for other variables. This approach identifies the points at which additional time using the program has the greatest impact on mastery.

Further, to identify distinct learner profiles within the Lexercise program, a cluster analysis was conducted. Key variables for this analysis included the number of levels mastered in the decoding assessment, levels completed since enrollment, months since enrollment, hours of program use in 2023-2024, number of months using the program in 2023-2024, baseline level in Lexercise at the start of the 2023-2024 school year, and average decoding accuracy. This analysis groups students based on patterns in their enrollment, usage, and achievement, helping to reveal different profiles of learners who may experience varying rates of mastery. By clustering students with similar characteristics, this analysis reveals how different patterns of usage and achievement trajectories are related to decoding mastery and long-term progress in Lexercise. Finally, these cluster classifications were used in inferential testing to examine whether significant differences exist between the clusters and to explore the implications of these findings for understanding distinct learner profiles and learner journeys in Lexercise.

Results

Student Usage and Assessment Design

Program Implementation and Student Usage

Students demonstrated strong adherence to the prescribed intervention model, averaging 15 minutes per practice session and three to four sessions a week, with expected slight dips in December and June (Figure 1). Student lesson completion averaged 3-4 lessons each month, maintaining the intended pace of instruction (Figure 2). The consistent accuracy throughout the 2023-2024 school year indicates that the pace of advancement aligned well with students' skill levels, with the material being neither too easy nor too hard (Figure 2). Overall, students adhered closely to the Lexercise guidelines for minutes per practice session, weekly practice sessions, and literacy specialist-assigned lessons.

Figure 1. Average Minutes per Practice Session & Number of Practice Sessions per Month

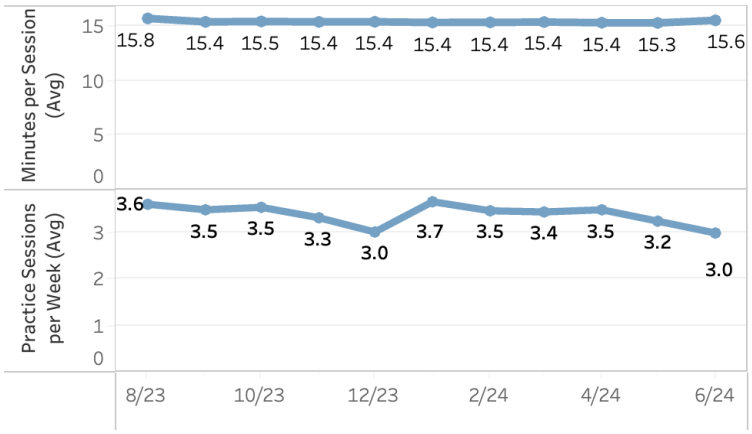
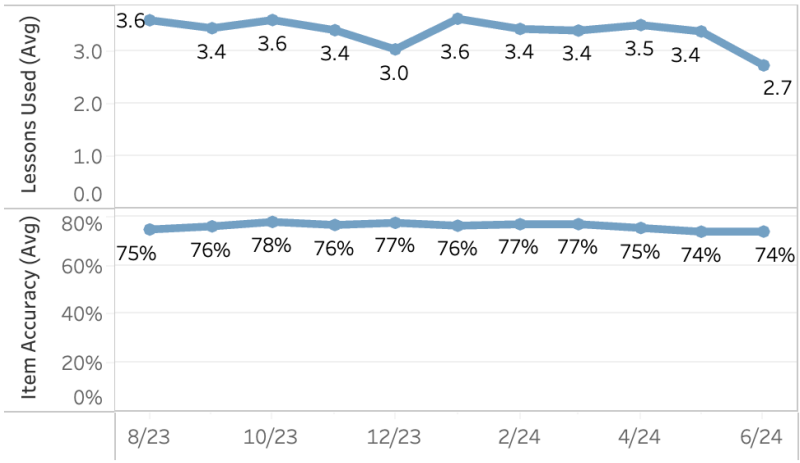


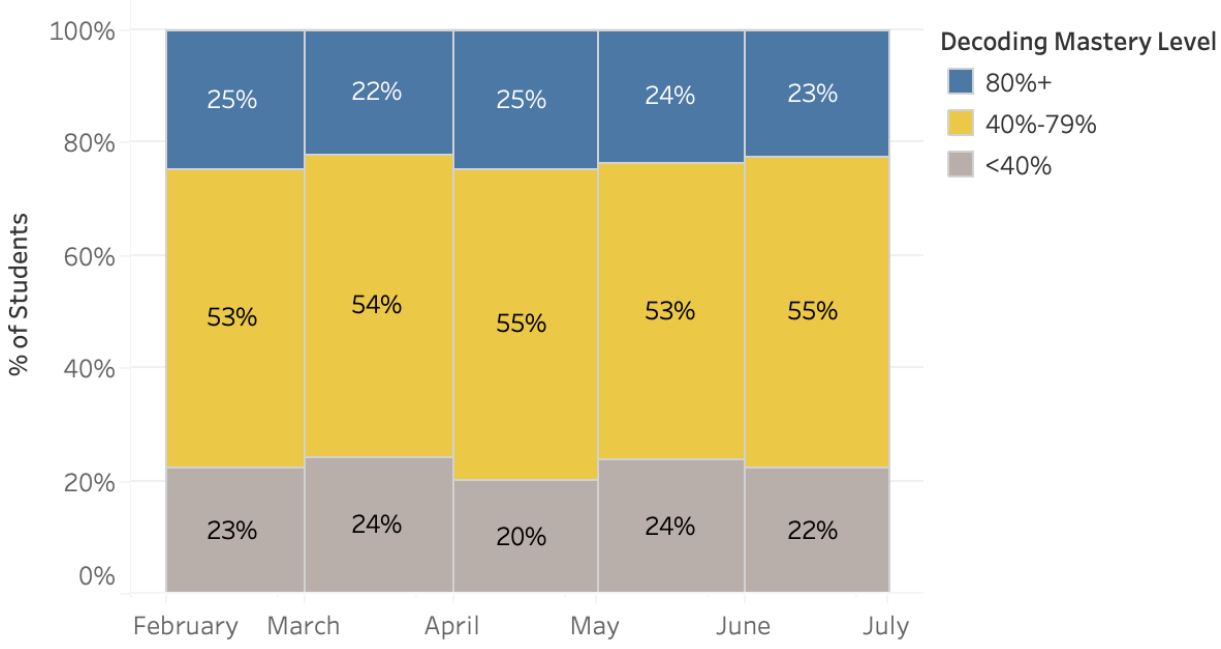
Figure 2. Average Number of Lessons Used & Item Accuracy per Month



Assessment Design and Performance

The composition of the decoding assessment was also analyzed to understand if students used it according to its intended design, considering student performance on assessment attempts across mastery ranges. The decoding assessment was designed to interleave skills from previous levels to review challenging items and provide additional opportunities to succeed. Only ten items long, the adaptive decoding assessment aimed to balance the difficulty distribution to allow for review without too much frustration, with approximately 20-25% of items resulting in low or high accuracy performance and most items in the medium range (Figure 3). This distribution suggests the assessment successfully maintained an optimal challenge level while providing necessary practice opportunities. The dynamic adjustment of test items based on student performance functioned as designed, effectively tracking skill development.

Figure 3. Decoding Assessment Performance by Month



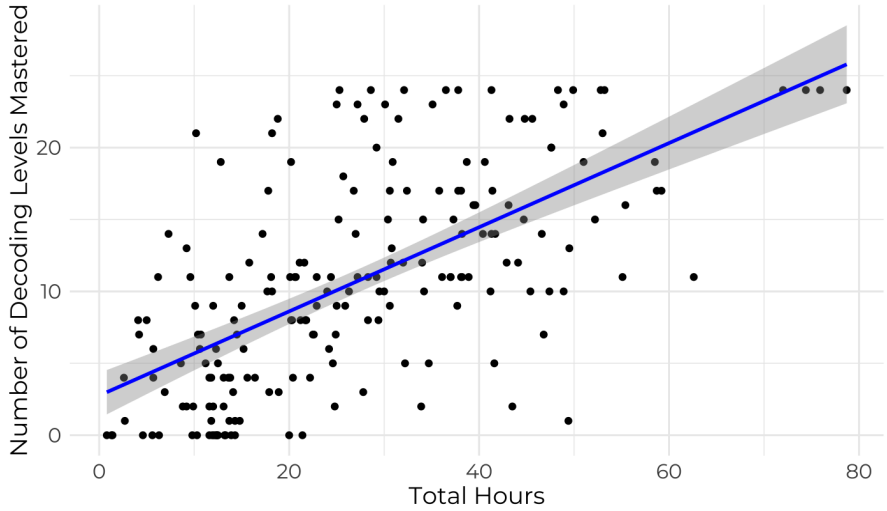
Notably, there was no significant relationship between decoding accuracy and the Lexercise level students were on (r = -0.02, p = .83), indicating that the quizzes maintained an appropriate difficulty level without being too easy. This adaptive design ensures that students are consistently challenged at a level suited to their progress.

Factors Related to Decoding Mastery

Correlations and Regressions

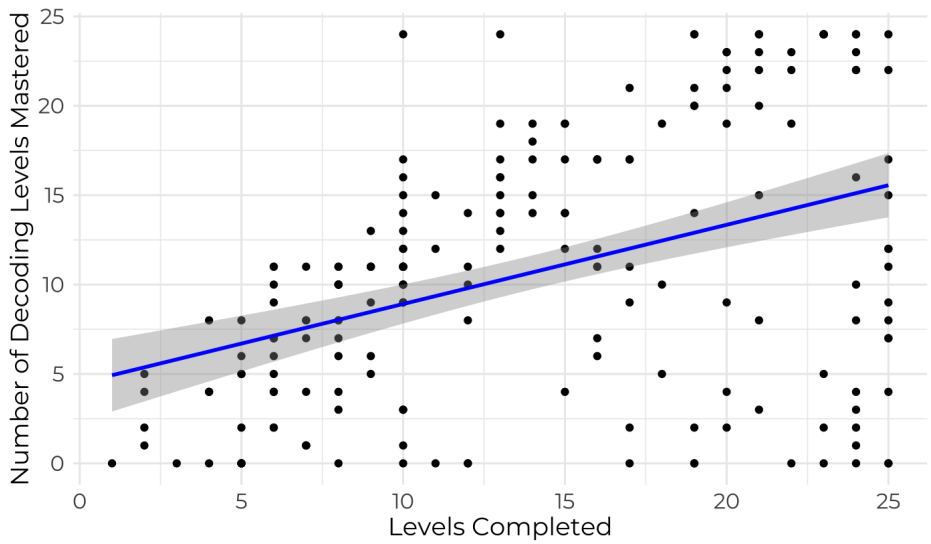
There was a strong, positive correlation between the total hours students spent using the program during the 2023-2024 school year and the number of decoding levels they mastered during the 2023-2024 school year ($r = 0.64$, $p < .001$). Linear regression analysis further indicated that total hours of program usage during the year significantly predicted decoding mastery, $\beta = .29$, $p < .001$, explaining 40% of the variance in decoding mastery. See Figure 4.

Figure 4. Correlation between Total Hours of Usage and Number of Decoding Levels Mastered



Additionally, there was a positive correlation between the number of Lexercise levels completed since enrollment and the number of levels mastered in the decoding assessment ($r = 0.41$, $p < .001$; Figure 5). Linear regression analysis further indicated that total Lexercise levels completed since enrollment significantly predicted the number of levels mastered in the decoding assessment, $\beta = .44$, $p < .001$, explaining 17% of the variance in decoding mastery. These findings suggest that progressing through program levels is closely associated with improved decoding concept knowledge, indicating that students benefit from sustained usage and cannot easily 'game' the system to advance without genuine skill development.

Figure 5. Correlation between Total Levels Completed and Number of Decoding Levels Mastered

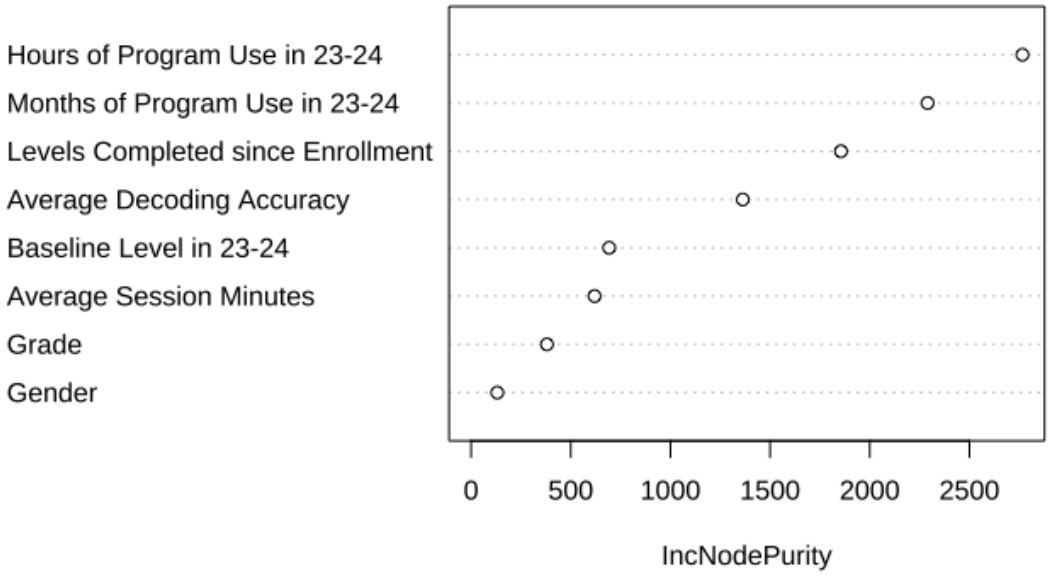


Random Forest

A random forest analysis was conducted to identify the key factors associated with the number of levels mastered in the decoding assessment in the Lexercise program during the 2023-2024 school year. Random forests provide a measure called 'increase in node purity' for each predictor variable, indicating its importance in relation to the target outcome. A higher increase in node purity suggests that the variable had a stronger influence on reducing variance in the predictions, making it more impactful in determining decoding mastery. This approach is useful for analyzing complex educational datasets, as it accommodates interactions between variables and handles non-linear relationships effectively, making it robust in identifying key predictors even when data contains noise (Breiman, 2001). Additionally, random forests have been recognized more recently for their versatility in educational research (Fife & D'Onofrio, 2023).

The independent variables included in this model were students' gender, grade level, baseline level at the start of the 2023-2024 school year, average practice session duration in minutes, average decoding accuracy, total Lexercise levels completed since enrollment, months of program use during 2023-2024, and total hours spent using the program during 2023-2024. These variables were selected based on both theoretical relevance and the need to minimize correlations among independent variables. Figure 6 below presents the relative importance of each variable in predicting the number of decoding levels a student mastered.

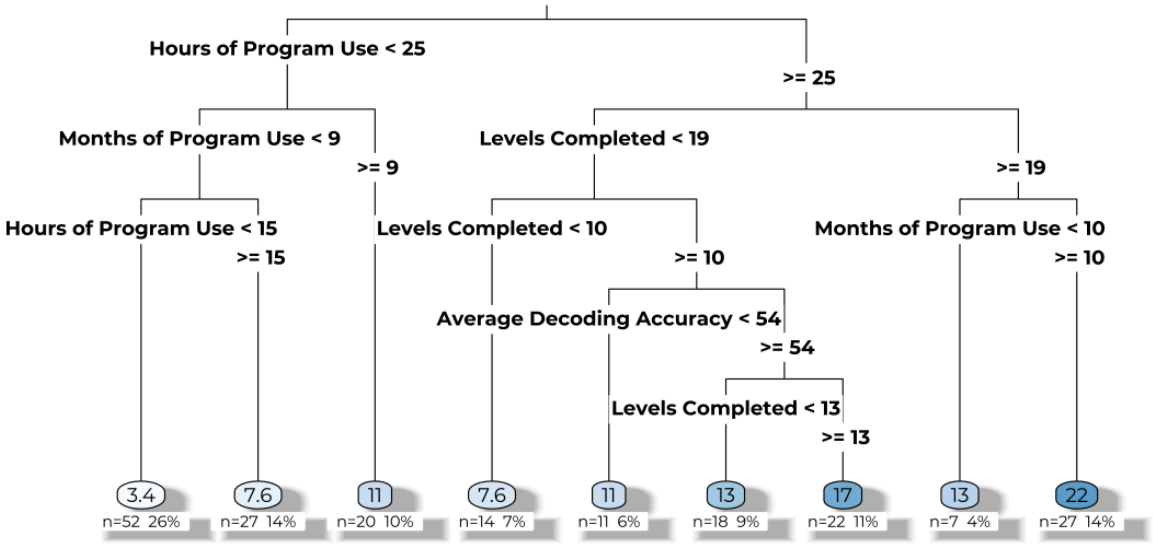
Figure 6. Variable Importance in Predicting the Number of Decoding Levels Mastered



As demonstrated above in Figure 6, total hours spent using Lexercise over the course of the 2023-2024 school year is the strongest predictor of student decoding mastery relative to the other variables. The number of months a student used the program in 2023-2024 and the number of levels a student has completed since enrolling in Lexercise were the next most important predictors, respectively. Notably, variables like baseline level in 2023-2024 were relatively less important when controlling for other factors, suggesting that the Lexercise level a student started the school year on was not an essential factor in how well they could continue to progress through the program and master decoding concepts. Similarly, average practice session minutes were also less predictive of decoding mastery in comparison to other variables, likely because of the consistency of students in completing their 15-minute practice sessions regularly.

To better understand these dynamic relationships, Figure 7 provides a decision tree from this model that illustrates how these various factors in the data contribute to decoding mastery. Importantly, the first split in the tree (i.e., total hours spent using Lexercise in the 2023-2024 school year) represents the factor with the greatest predictive power in determining the number of levels mastered in the decoding assessment. Figure 7 shows that students who spent 25 or more hours (i.e., 33 weeks of prescribed use) on Lexercise during the year were predicted to master more levels in the decoding assessment (ranging from 7.6 to 22 levels mastered) compared to those who spent less than 25 hours (ranging from 3.4 to 11 levels mastered). Each subsequent split reflects additional decision points based on key characteristics in the dataset, such as months of program use during the school year or Lexercise levels completed since enrollment, further refining the predictive pathway toward decoding mastery.

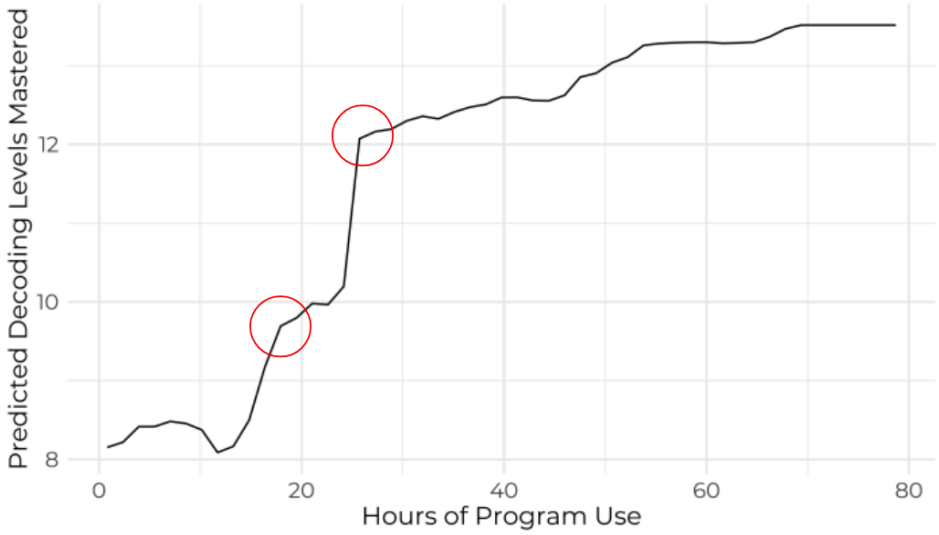
Figure 7. Decision Tree Model Identifying Key Factors Associated with the Decoding Mastery



Note. The colored numbers represent the number of levels mastered by the students in that corresponding subsample in the decoding assessment.

Following the decision tree analysis, a partial dependence plot was created to examine the specific effect of hours of Lexercise usage during the 2023-2024 school year on decoding mastery (Figure 8). While the decision tree identifies key decision points, this plot focuses on isolating the impact of hours of program usage, averaging out other variables to reveal its unique influence on predicted mastery levels. The line represents the model's predictions for mastery as hours spent during the school year increase, revealing key takeaways regarding the highest return on investment for students' time using the Lexercise program.

Figure 8. Effect of Lexercise Program Usage in 2023-2024 on Predicted Decoding Mastery



The partial dependence plot above highlights two important milestones for students in terms of their Lexercise usage. The first meaningful milestone occurs at 18 hours of use during the 2023-2024 school year, equivalent to approximately 24 weeks of usage at 45 minutes per week. At this turning point, students are predicted to have mastered about ten more levels of the decoding assessment than where they started. The second milestone is at 25 hours of use during the 2023-2024 school year, representing an estimated 33 weeks of use assuming 45 minutes per week, where students are predicted to have mastered about 12 more levels of the decoding assessment than where they started. This milestone appears to offer the maximum return on investment for students' time in terms of decoding mastery, consistent with the results of the primary split observed in the decision tree above (Figure 7). In practical terms, 33 weeks is roughly one school year, accounting for holidays and breaks. Figure 8 suggests that students who complete only about 12 hours of program use, or roughly half of the school year, are likely to show much less improvement compared to those who use Lexercise for up to 25 hours, or roughly the whole school year. With 33 weeks as a cut point, consistent use of Lexercise for one school year is expected to lead to mastery of decoding concepts across 12 additional levels.

Distinct Learner Profiles

Distinct learner profiles refer to categorizations of students based on individual characteristics or outcomes that distinguish groups of learners from one another. In the context of the Lexercise program, exploring learner profiles can help reveal variations in learning trajectories, including differences in decoding mastery, time spent in the program, and adherence to recommendations for the amount of program usage. By analyzing individual metrics such as levels mastered and total program usage, this approach allows for the identification of patterns that differentiate learners and the opportunity to highlight specific needs or challenges faced by each group.

Cluster analysis is a methodological approach that allows for the investigation of distinct learner profiles. A key strength of using cluster analysis to identify distinct learner profiles comes from its ability to evaluate important variables together, providing a holistic understanding of students' learning experiences rather than isolating relationships between individual variables. Cluster analysis is particularly well-suited for the current research questions because it allows for a data-driven approach to understanding diverse learning experiences. As an unsupervised machine learning method, cluster analysis is designed to group individuals into clusters based on similarity within groups and dissimilarity between groups (Steinley, 2006). This methodology is especially valuable in contexts where variability in student usage and outcomes may indicate opportunities to refine instructional strategies to better support learners.

Cluster Analysis of Distinct Learning Profiles

Cluster analysis identified three student groups that represent distinct learning profiles based on Lexercise usage and mastery (Figure 9). The silhouette method was used to determine the optimal number of clusters. The analysis incorporated several variables, including baseline Lexercise level at the start of the 2023-2024 school year, total months of enrollment, hours spent using the program during 2023-2024, months of program use during 2023-2024, total levels completed since enrollment, average decoding accuracy, and number of levels mastered in the decoding assessment. Categorical variables (e.g., grade level) cannot be added to a cluster analysis initially but can still be used to explore and interpret each learning profile.

Figure 9. Three Distinct Learning Profiles Found via K-Means Cluster Analysis

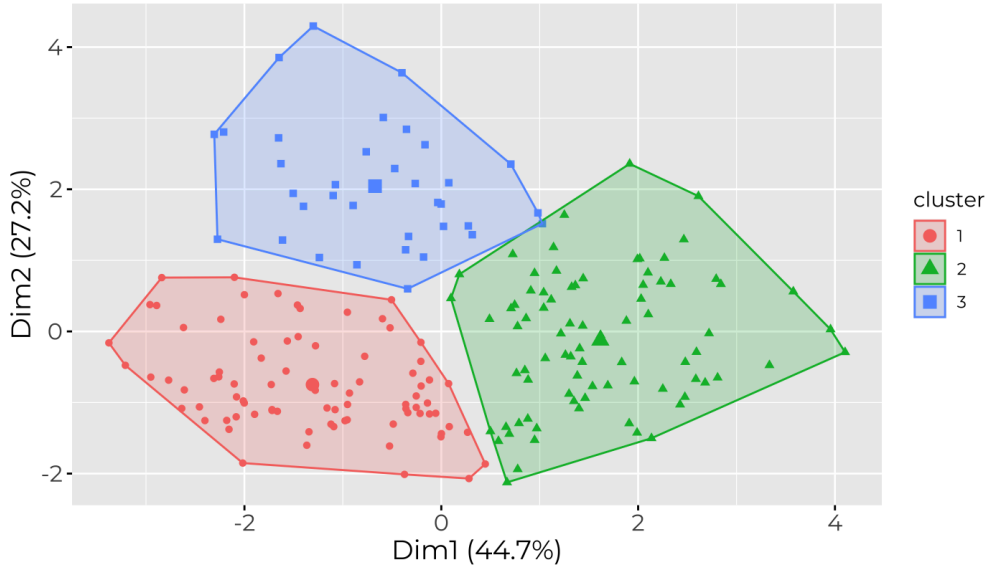


Table 2 presents the mean values of all relevant variables for each cluster. Broadly, students in Cluster 1 appear to be Early Learners. These students were younger, with moderate program usage and shorter enrollment, achieving steady but lower mastery gains. Cluster 2 involves Consistent Progressors. Composed of older students, this cluster demonstrated high program adherence and the strongest mastery progress. In contrast, Cluster 3 consists of Complex Learners who showed limited mastery despite high-level completion over the course of their enrollment, indicating potential challenges in assessment backfill or content complexity.

Table 2. Mean values of relevant variables for each learning profile cluster

Cluster	Mean Levels Mastered during 23-24	Mean Levels Completed since Enrollment	Mean Hours of Usage during 23-24	Mean Months of use during 23-24	Mean Baseline Level at start of 23-24	Mean Decoding Accuracy	Mean Months of Enrollment	Percent Male
Early Learners	7	8	20	6	2	56%	11	51%
Consistent Progressors	18	17	40	10	6	61%	22	54%
Complex Learners	4	21	15	6	11	48%	29	57%

Figure 10 and Figure 11 below show the distribution of grade levels and total months enrolled in Lexercise, respectively, split by cluster.

Figure 10. Distribution of Grade Level

Figure 11. Distribution of Total Months of Enrollment

Significant differences between learning profiles

The data reveal notable similarities and distinct characteristics across the three learner profiles—Early Learners, Consistent Progressors, and Complex Learners. Gender did not significantly differ between profiles (p = .827). However, significant differences emerged in terms of variables related to enrollment, program usage, and achievement. Table 3 highlights these distinct characteristics.

Table 3. Characteristics of Each Learner Profile

Characteristics		Learner Profiles		
		Early Learners (n = 82)	**Consistent Progressors** (n = 81)	**Complex Learners** (n = 35)
Enrollment	**Most Common Grade Level in 23-24**	Grades 2-3	Grades 3-5	Grades 3-6
	Baseline Level in 23-24	Low (M = Level 2)	Moderate (M = Level 6)	High (M = Level 11)
	Total Months of Enrollment	Less than a year (M = 11 months)	About two years (M = 22 months)	Over two years (M = 29 months)

Characteristics		Learner Profiles		
		Early Learners (n = 82)	**Consistent Progressors** (n = 81)	**Complex Learners** (n = 35)
Program Usage	**Hours of Use in 23-24**	Half prescribed time (M = 20 hours)	Exactly as prescribed (M = 40 hours)	Less than half prescribed time (M = 15 hours)
	Months of Use in 23-24	Half the year (M = 6 Months)	Nearly all year (M = 10 Months)	Half the year (M = 6 Months)
Achievement	**Decoding Levels Mastered in 23-24**	Moderate (M = 7 Levels)	High (M = 18 Levels)	Low (M = 4 Levels)
	Level Completion since Enrollment	Moderate (M = 8 Levels)	High (M = 17 Levels)	High (M = 21 Levels)

The findings presented in Table 3 demonstrate the statistical evidence that each profile represents a significantly different learning experience. Note: mean is designated by "M."

Enrollment. Related to overall enrollment in Lexercise, Complex Learners began the 2023-2024 school year at a significantly higher baseline level than Early Learners ($p < .001$) and Consistent Progressors ($p < .001$). Consistent Progressors began the school year at a significantly higher baseline level than Early Learners ($p < .001$). Further, Complex Learners have been enrolled in Lexercise for significantly more months than Early Learners ($p < .001$) and Consistent Progressors ($p < .01$). Consistent Progressors have also been enrolled in Lexercise for significantly more months than Early Learners ($p < .001$). In summary, Complex Learners have been enrolled in Lexercise the longest and started the school year at the highest level, followed by Consistent Progressors, with Early Learners having the shortest enrollment duration and the lowest baseline level at the start of the school year.

Program Usage. Related to program usage during the 2023-2024 school year, Consistent Progressors spent significantly more months using Lexercise during the school year than Early Learners ($p < .001$) and Complex Learners ($p < .001$). The number of months actively using Lexercise during 23-24 did not significantly differ between Early Learners and Complex Learners ($p = .712$). When considering hours of usage rather than months of usage, Consistent Progressors also spent significantly more hours using Lexercise during the school year than Early Learners ($p < .001$) and Complex Learners ($p < .001$). Similar to the comparison of months, hours of Lexercise usage did not significantly differ between Early Learners and Complex Learners ($p = .130$). In

summary, Consistent Progressors uniquely demonstrated greater adherence to the prescribed program usage, spending significantly more hours and months using Lexercise compared to Early Learners and Complex Learners. Early Learners and Complex Learners did not significantly differ in their program usage.

Achievement. Related to achievement, Complex Learners completed significantly more Lexercise levels over the course of their time enrolled in the program than Early Learners ($p < .001$) and Consistent Progressors ($p < .001$). Consistent Progressors also completed significantly more Lexercise levels over the course of their time enrolled in the program than Early Learners ($p < .001$). When considering decoding mastery, Consistent Progressors mastered significantly more levels in the decoding assessment during 2023-2024 than Early Learners ($p < .001$) and Complex Learners ($p < .001$). Complex Learners also mastered significantly more levels in the decoding assessment during 2023-2024 than Early Learners ($p = .032$). In summary, Complex Learners have had more time in the program, allowing them to complete more levels than the other clusters, while Consistent Progressors uniquely excelled in decoding mastery during the 2023-2024 school year. Early Learners, still at the start of their learning journey, demonstrated the lowest achievement across both measures.

In all, key differences between the profiles are particularly evident in terms of decoding mastery and program usage during the 2023-2024 school year (see Table 4 for a summary).

Table 4. Overall descriptions of each learner profile cluster

Cluster	Learner Profile Description
Early Learners	• Enrollment: Shortest enrollment duration, typically less than a year • Usage: Moderate program usage, completing half the prescribed program usage during the 23-24 school year • Achievement: Beginning their learning journey, with the lowest levels completed and decoding mastery relative to other clusters
Consistent Progressors	• Enrollment: Moderate enrollment duration, around two years • Usage: Highest program usage, adhering to the prescribed program usage during the 23-24 school year • Achievement: Strongest decoding mastery achievement during the 23-24 school year, significantly outpacing other clusters
Complex Learners	• Enrollment: Longest enrollment duration, over two years • Usage: Moderate program usage, similar to Early Learners in active usage • Achievement: Highest levels completed across their enrollment but low decoding mastery demonstrated during the 23-24 school year

Discussion

The literacy crisis in the United States is reaching critical levels, with recent data revealing significant reading recovery challenges post-pandemic. Late elementary and middle school students are reading below basic proficiency, compounded by a shortage of reading specialists in secondary schools. In response to these challenges, Lexercise has emerged as a promising solution, offering a hybrid model that combines weekly reading intervention lessons with digital independent practice. The current study examined the usage and effectiveness of Lexercise in supporting reading skill development among struggling readers. The present findings suggest that structured, technology-enhanced reading intervention can effectively support reading skill development when implemented with fidelity, though implementation strategies may need adjustment based on learner profiles.

The study found that students showed strong adherence to the Lexercise intervention model, consistently completing 15-minute independent practice sessions 3-4 times per week and covering 3-4 lessons monthly. The adaptive decoding assessment effectively maintained an optimal challenge level, with 20-25% of items at low accuracy and the remainder split between medium and high accuracy. Having at least half of the items in targeted intervention practice be familiar or (i.e., medium and high accuracy) has been linked with large positive effects on student performance (Burns, 2024). The purposeful design of the Lexercise adaptive decoding assessment also aligns with guidelines about adjusting the level of difficulty for the learner and keeping individual practice sessions relatively short (Burns & Contesse, 2024; Poncy et al., 2015).

Program data revealed a strong positive correlation between total program time and decoding mastery, suggesting that students' progress reflected genuine skill development rather than superficial advancement. In some ways, this may be due to the Lexercise program design, which includes correctly targeted areas of instruction with high opportunities to respond and engage in sufficient practice, which is in alignment with research on best practices for delivering reading intervention (Burns & Contesse, 2024; Wisniewski et al., 2020). The Lexercise lessons at each level of the program are also followed by explicit feedback, allowing for targeted error correction and opportunities for retry and correction (Burns & Contesse, 2024; Wisniewski et al., 2020).

Analysis of learning patterns revealed three distinct learner profiles: Early Learners (younger students with moderate usage), Consistent Progressors (older students with high adherence), and Complex Learners (students with high-level completion but limited mastery). More specifically, Early Learners showed moderate decoding mastery with relatively limited total hours and months in the program during the 2023-2024 school year. This profile likely represents students who are just beginning to use the program and may benefit from additional support to increase their consistency in usage to achieve higher mastery levels. In contrast, Consistent Progressors exhibited the highest decoding mastery and adherence to program expectations during the 2023-2024 school year, with substantial usage in terms of hours and months of use. These

students demonstrated steady progress and commitment to the program, achieving significant mastery in decoding concepts through sustained participation. Finally, Complex Learners started the year at a higher level but exhibited lower decoding mastery and fewer total hours of program usage during the school year, indicating that despite—or possibly due to—beginning with more advanced concept knowledge, they faced challenges maintaining the recommended usage patterns for steady progress.

Consistent Progressors exemplify the potential benefits associated with continuous usage of Lexercise, suggesting that it may be beneficial to encourage regular and prescribed usage patterns to maximize learning outcomes. Complex Learners might benefit from interventions aimed at maintaining motivation and addressing specific barriers to mastery. Early Learners, on the other hand, might benefit from additional resources to boost engagement and extend their time in the program, potentially helping them become Consistent Progressors.

These profiles helped illuminate how different students engage with and progress through the program. The learner profiles observed here may reflect common patterns of usage that extend beyond the current sample. Given the dynamic and adaptive nature of educational tools, understanding common learner profiles may be useful for informing customized learner paths or targeted suggestions when students engage with programs in a certain way, providing support that caters to learners' needs.

Limitations

Although this study reveals promising evidence for the effectiveness of Lexercise across different learner profiles, some limitations of the study design should be considered. The study focused on private reading intervention implementation, which limits the ability to interpret how this may generalize to school-based settings, where other factors may influence the completion of lessons and activities. In addition, although cluster analysis helps reveal potential learner profiles, different samples may bring different characteristics to the table, which could influence their use of Lexercise in ways different from those observed here. In addition, the measures in this study were part of the Lexercise system, making it hard to know how these results would compare to an external, standardized assessment of student progress. Finally, the sample size was relatively small, which also limited conclusions about generalizability across larger groups of students.

Conclusion

The findings demonstrate that Lexercise effectively supports reading skill development when implemented with fidelity. The strong correlation between program usage and mastery suggests that the structured practice approach succeeds in building reading skills. The identification of optimal usage thresholds (24 and 33 weeks) provides valuable guidance for implementation planning.

The emergence of distinct learner profiles highlights the importance of differentiated support strategies. While younger students showed consistent progress with the standard implementation model, older students required additional time for mastery, particularly at higher levels. This suggests a need for adjusted expectations and potentially modified support structures for older learners.

Future research should examine implementation effectiveness directly in school-based settings and consider student performance across a longer time frame. It would also be valuable to investigate factors affecting older students' progression rates and to explore additional support strategies for learners who may need them. In addition, including the Lexercise Spelling Mastery Assessment in addition to the Decoding Mastery Assessment analyzed here would help consider the program's impact on both of these key skill areas. Finally, comparing these results to those of standardized assessments would help understand student skill levels and their progression even more.

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