

Article

Lyrics2Learn: Teaching Fluency through Music and Technology

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Abstract: Since 1992, our nation's report card (NAEP) has indicated minimal improvement in reading. One of every three fourth grade students cannot read or understand text at a basic proficient level. At the same time, reading curricula publishers have approached reading improvement in similar ways. Recent advancements in technology allow educators to reconsider how to personalize learning and individualize the pace of instruction to address reading disparities. The current study examines the implementation of a new technology application for reading, Lyrics2Learn (L2L). L2L was used over one school year by 463 students, kindergarten to third grade across nine schools in a large urban school district. Achievement data was collected from L2L students and a matched sample of students not using L2L. L2L teachers also provided perception data via an online survey. L2L program analytics were collected to document usage and implementation fidelity. At the end of one year of implementation, L2L students did not significantly differ from non-L2L students on achievement measures. Very few teachers implemented L2L with fidelity, however they reported that it was easy to use and supported differentiation of instruction. The current study has implications for how technology can support individualized reading interventions and classroom innovation.

Keywords: reading comprehension; reading fluency; early literacy; technology

1. Introduction

In the USA, students arrive to kindergarten from highly variable experiences with formal learning [1]. Experiences prior to kindergarten provide the building blocks of later achievement. Children missing critical early learning experiences begin school at a significant disadvantage [2]. As early as kindergarten, the Common Core State Standards which guide many learning expectations in the United States, expects students to relate concepts to themselves and the world around them. This becomes a challenging task for students who do not have practice to be able to absorb and relate information from the text. These disadvantages continue into later grades. In fact, the National Center for Education Statistics showed that Black and Hispanic students trailed their White peers by an average of more than 20 test-score points on the NAEP math and reading assessments at fourth and eighth grades, a difference of about two grade levels [3,4].

Fundamentally, students need to be able to learn and understand complex reading concepts. Practice is always needed to build these foundational skills, but it does not speed up comprehension or fluency improvement [5]. In the USA, research has found instruction that is led by the teacher in a small group addressing specific needs, often 15 min per day, three to four days per week has meaningful impacts on student achievement [6,7]. Similarly, reading instruction in the early grades (K-3) most often includes a combination of independent reading practice, online reading practice (sometimes with application), and small or large group work in which reading is applied to various concepts and activities determined by

the curriculum [8]. With US students entering kindergarten at varying levels, the challenge of getting students to read at grade level can be even more difficult. More than ever, US teachers are expected to meet greater demands in their classrooms with a more diverse student population.

Supplemental programs aimed at filling reading gaps and raising achievement scores need to be easy to use for both students and teachers. Programs that save time, money, and work may be more readily adopted by teachers. If a program's implementation requires significant amounts of teacher and student training, and extra materials, adoption may be difficult [9,10]. Recent advancements in technology position technological tools to be a cost-effective means to reduce these educational gaps [11].

When used appropriately, technology creates access and equitability, supports relationships between educators and students, and provides individualized learning experiences to meet the needs of all learners. The conversation has shifted from whether technology should be used in classrooms to how it can be used to increase access and personalize learning. Access to technology has also made significant progress in terms of both high-speed connectivity and cost. While significant progress has been made in educational technology applications, a digital use divide continues to exist between learners who are using technology in active, creative ways to support their learning and those who predominantly use technology for passive content consumption. Lyrics2Learn (L2L) is a technology application that uses rhythm and music to teach reading fluency and has the promise to address the gaps in reading achievement. Additionally, L2L allows teachers to individualize learning with technology rather than provide a passive distraction in the classroom. The current paper explores the impact of L2L on student reading achievement. But first, we briefly review the research basis of L2L to ground the discussion.

1.1. Rhythm and Reading

Four foundational skills are widely accepted by US national standards as prerequisites for reading. These include print concepts, phonological awareness, phonics and word recognition, and fluency as they support the transformation of converting print into a meaningful linguistic code [12]. In particular, fluency is important because it is considered a prerequisite for students to read and understand what they have read. Reading fluency has been defined as "reasonably accurate reading at an appropriate rate with proper prosody (the pitch, tone, volume, emphasis, rhythm of oral reading) that leads to accurate and deep comprehension and motivation to read" [13]. Fluency is not the same as rate or speed, and having students learn to read as fast as possible will not increase their reading proficiency [14]. Instead, fluency is considered a complex skill requiring accuracy and rate. Research has identified fluency as a critical goal in reading [15,16]. A fluent reader is reading with automaticity, in other words reading without having to think about it at a conscious level, leaving the brain to attend to the meaning of the text being read [17].

Strategies similar to those used by L2L shown to increase fluency often focus on providing the reader opportunities to practice repeated readings. For example, 'tape assisted reading' which uses oral-assisted reading techniques, was found to increase reading fluency and overall reading achievement [18–20]. Gains were also reported with tape assisted reading for students' attitude toward reading and teachers' ratings of student's classroom reading performance [21].

Furthermore, research on repeated readings of relatively brief texts such as poems have been shown to improve fluency [22]. Poems are meant to be spoken aloud and are authentically read repeatedly as the reader rehearses their performance. Additionally, poems are rhythmical in nature supporting the development of prosody, a key component of fluency that is not often addressed in most fluency programs. In one recent study, students who received reading instruction, using poetry, made significantly greater gains in word recognition, fluency, and comprehension than they had previously been making in a more traditional school setting [23]. Young and struggling readers may be motivated by the tempo, cadence, and sound of the poetry, providing the opportunity to learn vocabulary in meaningful and efficient ways.

Similar to poetry, songs naturally lend themselves to re-readings [24]. Skills such as blending and segmenting sounds needed for music production are similarly used in language processing [25].

Studies examining the use of music or lyrics and reading fluency have consistently shown positive results [26–30]. Specific singing-integrated strategies, specifically the use of songs, may also enhance reading motivation [31]. Adolescent students who heard repeated readings set to song and lyrics instead of regular passages showed greater gains in fluency as well as increased motivation for fluency activities [27]. Additionally, when words of the text were familiar, such as favorite songs, children experienced more success in learning to read [31]. Similarly, an intervention using popular children’s songs portrayed in picture books to teach fluency to third graders had positive impacts on automaticity [32]. Automaticity as previously discussed is important to free up more cognitive energy necessary for reading comprehension [33].

L2L builds off the research base of these foundational fluency programs and extends it further by using computer technology and readings set to music, to offer repeated reading opportunities as well as rapid feedback on performance to scaffold the student experience.

1.2. Lyrics2Learn (L2L) and Reading Fluency

Lyrics2learn (L2L) is an online reading application created by a veteran classroom teacher with 15 years of experience. L2L started with eight stories, broken up into 4–15 min activities used as a daily independent reading center while the teacher ran tiered reading groups. As previously stated, L2L is grounded in research on the benefits of music to engage students with text, make repeated reading fun, and help students memorize information quickly. Stories are repeated daily and set to rhythm and rhyme, increasing students’ retention of the information and their performance on question levels (aligned with the Common Core Depth of Knowledge levels (D.O.K) 1, 2, and 3). Over time, the first eight stories, ranging from the history of Abe Lincoln to learning about empathy, grew to over 200 original texts, organized into more than 800 activities. 50% of the stories are fiction, most of which teach students about character building with concepts and real-life examples of honesty, perspective, grit, and cooperation.

Although L2L is focused on reading improvement, teachers also integrate science, history and other subjects into reading with non-fiction texts. Each story, whether fiction or non-fiction, addresses fluency, literal comprehension (Day 1), inferential comprehension (Day 2), complex concepts stressing text-to-self and text-to-world connections (Day 3), and open ended short constructed response paragraphs requiring students to support their answers with examples from the text (Figure 1).



ONE PEOPLE

character building, fluency, constructed response, main idea, cause and effect, vocabulary, compare and contrast, significance of events, sequence of events, author's purpose, citing details



Day1
Lesson



Day2
Lesson



Day3
Lesson



Lesson
Extension



Lesson
Worksheets

Genre	WPM	Subject	Lexile Level
F	160	Character	650

Figure 1. L2L lesson plan.

Text written with rhythm, rhyme and simple melodies, makes fluency practice fun, multi-sensory and engaging. The monotonous (but time-tested and proven) fluency strategies of repeated and choral reading, suddenly become head-bopping sessions of reading and re-reading cool song lyrics until they are memorized. Table 1 below presents how components of L2L support specific fluency skills.

Table 1. Fluency skills addressed by L2L.

Fluency Skill	L2L Support
Reading with sufficient accuracy and rate to support comprehension.	L2L texts are read repeatedly to improve automaticity, prosody, and accuracy. Each story is read nine times throughout the one-week lesson.
Reading on-level text with purpose and understanding.	Teachers begin each student by assigning them to a reading level. Practice stories are then organized by lexile level and word per minute (WPM) so students using L2L read text on their own grade level and progress through lessons created to bring them in and out of their comfort zone, or independent reading level.
Reading on-level text orally with accuracy, appropriate rate, and expression.	Students are instructed by the animated guide, “Lefty Lyric” to read along with each day’s lesson out loud. Because of the repetition, each oral reading becomes more and more accurate as students become familiar with the song/text. The musicians in the stories use a variety of expression and the prosody is modeled by the student as they read. Because music is also a good way to provoke emotion, students feel what they read on a higher level, allowing for an authentic emotional connection to text.
Using context to confirm or self-correct word recognition and understanding.	Students are seeing and hearing text as they read along. When mistakes are made with word recognition, students hear the correct pronunciation of the word simultaneously and as they read repeatedly, the music, rhythm and rhyme help them improve their accuracy as they progress through the repeated readings.

Students read along with musicians three times each day. The words are ‘chunked’ or highlighted in phrasing groups to help students learn to track ahead as they read (Figure 2). The music is intended to provoke emotion, and help kids feel and visualize events in the story.

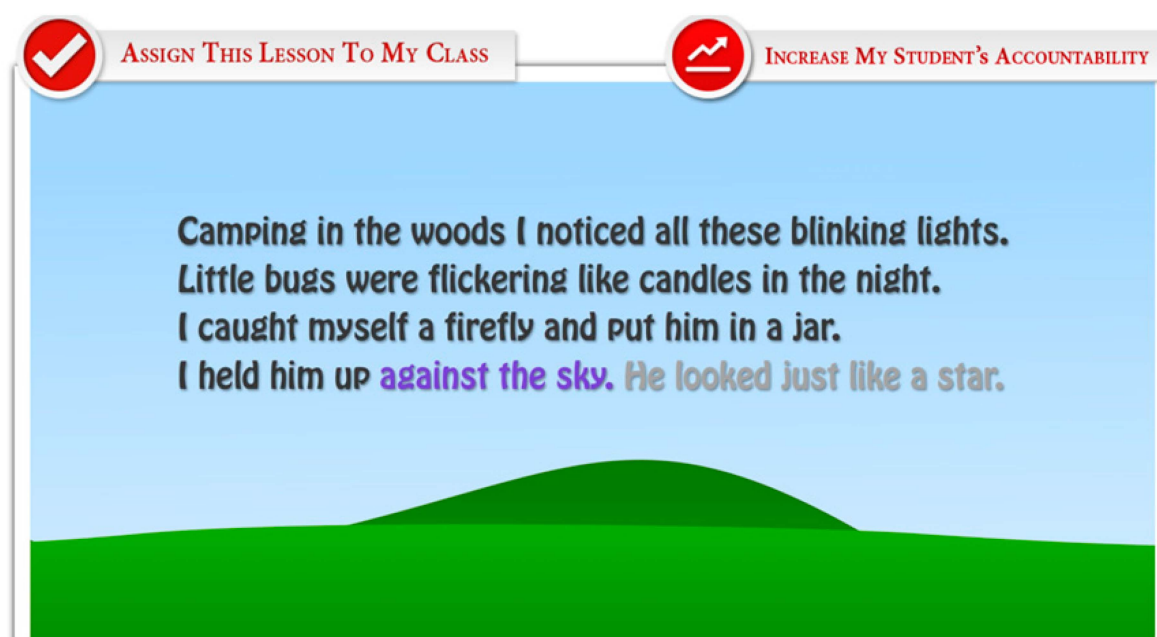


Figure 2. Sample L2L text.

In L2L's first eight-week anecdotal study at the teacher-creator's school, DIBELS fluency improvement rates went up 50–100%. None of these students decreased in their oral reading fluency (ORF) [34]. The average gain was 20 words per minute (WPM), and the highest was a gain of 68 WPM. Students that had essentially flat-lined through the first 16-week semester were more engaged to complete lessons effectively and independently. In the classroom, teachers able to provide more instructional time to small groups during reading rotations.

Because the students memorize lyrics (both informational and fictional text) so quickly, they gain confidence in their ability to think through high level questioning. In short, kids read the same story three times each day, three days a week, and find repeated, choral reading fun and enjoyable. Each day, as rhythm and rhyme allow students to retain more of the text, the question level becomes more complex. Day 1 is literal, day two inferential, and Day 3 text-to-self and text-to-world connections. The last question of every story addresses open-ended critical thinking and constructed response.

Each day's quiz allows students to check the text and is guided by "Lefty Lyric" who offers comprehension strategies and test taking skills related to the questions (Figure 3).

Hot Tips

Martin Luther King Jr.

He's Martin Luther King, with a Junior at the end. African Americans fought for equality, for a race that was white, not one above the other, because of him.

He had the same name. The middle name was Martin. There was no fear for truth. The way is not always easy. He led boycotts and marches. Our entire country was changed.

When the colors, they disappeared from the world. These people who stood up for what was right, means they changed the world went to jail, though it wasn't fair. People showed their trust.

He knew it's true, because those who stand up for what's right. "At the center of the universe, a principle is something that would not look away when you speak for truth and against injustice."

When none should bear. He had the hate with daring care. He was of our skin, instead to look at someone else's.

at character, who someone is within. He said, "Love is so strong, it can make your foe a friend," and fought for that truth, until the bitter end.

This world is full of everyone and everything there is. So we must keep an open mind and educate our kids. The first big step to change the world is looking at ourselves. We've got to grab those books of knowledge, pull them off the shelves. Read and think and act with sense, like Martin Luther King (Jr), and then my friends across the land, you'll hear freedom ring.

1) How do you think the author of this story feels about Martin Luther King Jr?

- ☐ A) He thinks he's a show off.
- ☐ B) He thinks Martin Luther King Jr. was an American hero.
- ☐ C) He thinks he made poor decisions.
- ☐ D) He thinks Martin Luther King is a good writer.

2) If Martin Luther King Jr. were here today, what might he say?

- ☐ A) I believe every man is equal.
- ☐ B) The world needs more laws.
- ☐ C) I cannot stand the way everyone looks at me.
- ☐ D) You must not believe everything you hear.

3) What does it mean to keep an open mind?

- ☐ A) To make sure your ears are open because they lead to the brain or mind.
- ☐ B) Be sure of your decisions.
- ☐ C) Always learn new things and listen to new ideas.
- ☐ D) Allow air in your head by keeping it open.

4) The text says King and others "sparked" a

Figure 3. Sample L2L quiz.

L2L's strategies and design were ultimately developed to address the gaps in reading achievement by supporting teachers to individualize learning with technology. To accomplish this, L2L builds off of the existing research base on music and reading fluency and extends it further by using computer assisted technology to offer repeated reading opportunities. Furthermore, L2L's technology offer rapid feedback on performance to scaffold the student experience.

2. Materials and Methods

The current study examines the use of L2L over one school year by 463 students, from kindergarten to third grade across nine schools in a large urban school district. Usage and achievement data was collected from these L2L students and a matched sample of students from the same school district in classrooms not participating in L2L. Data collected from teachers consisted of an online survey administered at the beginning and end of the program year. Program implementation data in the form

of user analytics was collected to document usage and implementation fidelity. Finally, DIBELS and PARCC data were collected to assess impact of L2L on student achievement outcomes.

2.1. Measures

Dynamic Indicators of Basic Early Literacy Skills (DIBELS)

The Dynamic Indicators of Basic Early Literacy Skills (DIBELS) is an assessment comprised of multiple indicators used to monitor early literacy and reading skills. The DIBELS assessment is broken into a set of “procedures and measures for assessing the acquisition of early literacy skills from kindergarten through sixth grade” [35]. The content areas measured by DIBELS include: phonemic awareness, alphabet principle, accuracy and fluency with connected text, reading comprehension, and vocabulary. DIBELS is often used as a tool to identify students in need of early literacy skills [36].

The DIBELS assessment was administered across the district multiple times during the school year: at the beginning, midpoint, and end. The current study included the following DIBELS categories, oral reading fluency (DORF), retell fluency (RETELL), and a composite score (composite). The composite score is an amalgamation of the seven measured content areas previously listed [36]. It should be noted that most of the kindergarten participants’ data by category were not included in the shared data set.

2.2. Colorado Measures of Academic Success (CMAS)

The Colorado Measures of Academic Success (CMAS) was developed in collaboration with the Partnership for Assessment of Readiness for College and Careers (PARCC). The CMAS/PARCC is administered across the district in the current study from kindergarten through sixth grade [37]. The CMAS assessment measures reading and is broken down into the following subcomponents: reading literature, reading information, vocabulary interpretation and use, written expression, and knowledge of language and conventions. Students are measured across three rubrics: text complexity, range of accuracy, and quality of evidence. Assessors then indicate a performance level for students ranging from 2 through 5, 2 representing ‘partially meets expectations’ and 5 representing ‘exceeds expectations’ [38]. The district utilizes the Galileo web-based assessment platform that allows for customization of measures for early literacy skills.

2.3. Teacher Perception Survey

The Teacher Perception Survey was administered electronically to all teachers using L2L in their classroom in the current study at the beginning and the end of the school year. The survey was developed following research-based guidelines that include five steps to ensure that the time spent creating, administering, and tabulating data leads to accurate and useful information [37]. The five steps are outlined below.

1. Determine the goal or goals of the survey: The L2L Teacher Perception Survey was administered to assess three primary goals, (1) L2L implementation, (2) L2L impact, and (3) L2L value.
2. Define the information needed to address each goal: A list of information needed to address the three goals was generated. For example, to understand teacher perceptions of L2L impact, Goal 1, information on the perceived effectiveness of L2L, student engagement with L2L, and so forth is required. The list was then reviewed internally to ensure that the items were clear, essential, not redundant, and captured all the information needed to address the goals.
3. Write the questions: Writing the questions involved three substeps: estimating how many questions to include, drafting the questions, and conducting an internal review. The final survey included a total of 15 questions, which was decided based on the audience (teachers), their interest in the topic, and the amount of time available to complete the survey [39]. Questions were drafted to address each of the three goals. During the drafting process existing surveys that address similar goals were reviewed. To decrease cognitive burden and increase accuracy [40,41], mostly

close-ended questions were utilized with some open-ended questions as options. Because the survey was administered electronically, questions on similar topics were grouped together for ease of use [42] and checkboxes for responses were provided instead of asking respondents to type responses. An internal review was conducted on this initial set of questions to ensure that each had only one interpretation and adheres to research-based guidelines for writing questions [39–45]. Questions were revised if they were found to be misinterpreted or elicited responses that did not address the three primary goals.

4. Review the survey for alignment with goals and adherence to research-based guidelines for writing questions: A revised draft survey was reviewed by individuals who were not involved in its creation to ensure that the questions align with the goals and information needed, follow research-based guidelines, and can be easily interpreted by respondents. Adjustments to the draft survey were made if questions were deemed to collect unnecessary information or did not align with the goals of the study. Table 2 provides sample questions that address each of the three primary Teacher Perception Survey goals.
5. Organize and format the survey: It was determined that the survey would be administered online because of its convenience and given that all respondents had access to the necessary technology [45].

Table 2. Teacher Perception Survey goals and sample questions.

Survey Goal	Sample Question
(1) L2L implementation	How do you use Lyrics2Learn in your classroom? (check box choices)
(2) L2L impact	Lyrics2Learn has improved my students' reading fluency. (agreement scale)
(3) L2L value	Lyrics2Learn has enhanced my understanding of using technology to personalize learning. (agreement scale)

2.4. User Analytics: Implementation Fidelity

Fidelity for using L2L requires students to complete approximately 100 lessons over the course of the school year—this translates to the completion of three lessons per week, approximately 33 weeks per school year. Furthermore, a complete lesson for L2L is defined as scoring 80% or higher on a lesson quiz. L2L developers set these criteria as fidelity for program implementation as three lessons completed independently each week during reading centers is the intended design for L2L implementation to integrate feasibly into most classroom's one-week planning schedules and requires very little management by the teacher. The L2L web platform automatically collects data on student usage of lessons and quiz scores as this information is used to generate teacher formative assessment reports. To assess implementation fidelity in the current study related to student outcomes, student L2L usage data over the course of the school year was collected, including number of lessons completed by month and quiz scores for each lesson completed.

2.5. Methods

To assess student outcomes measured by both the DIBELS assessment and the PARCC assessment, we used propensity score analysis. This statistical approach is often used when experimental designs are not feasible and observational data is used to discern the impact of an intervention [46]. Propensity score analysis helps to correct the bias from nonrandom assignment of participants in an intervention, but it cannot correct for unmeasured confounding variables [46]. Given the voluntary participation of both teachers and students in Lyrics2Learn (L2L), this method will allow a better understanding of student growth on the standardized assessments and an estimation of the causal effect of using L2L.

2.6. Sample

The current study included 463 students from kindergarten to third grade across nine schools in a large urban school district using L2L. Table 3 presents demographic information for the L2L students

compared to their non-L2L peers in the district. This full sample was utilized for the propensity score matching described in the Results section.

Table 3. Demographics by participation.

	Gender		Minority		FRL		SPED	
	Female	Male	Yes	No	Yes	No	Yes	No
L2L	227	288	236	279	325	190	43	472
Non-L2L	4048	4369	4102	4315	5195	3222	785	7632

It is important to note that information regarding literacy intervention participation for non-L2L participants was unknown and unaccounted for in the analyses. However, this district utilizes Wonders as its main curriculum, with each school organizing its literacy block slightly different. Wonders is a flexible literacy intervention program, grounded in research that provides scaffolded support designed to accelerate students back to grade level [47]. L2L Teachers reported using other literacy interventions as well, information on these interventions are listed in Table 4 below.

Table 4. Literacy interventions reported by L2L teachers.

Literacy Intervention	Count	Percentage
Wonders Online	20	95%
Accelerated Reader (AR or STAR)	19	90%
No other Technology	0	0%
Tween Tribune	1	5%
<i>n</i> = 21		

For each grade, actual participation in L2L and actuality of testing differs as students begin school through third grade (Figure 4). For example, kindergarten and first grade students in this sample do not collectively participate in the DIBELS Fall assessment. Because only a small sample of students participated in DIBELS Fall assessment ($n < 10$), this assessment was not used to analyze student reading performance. The analyses are divided by grade to provide additional insights into student outcomes.

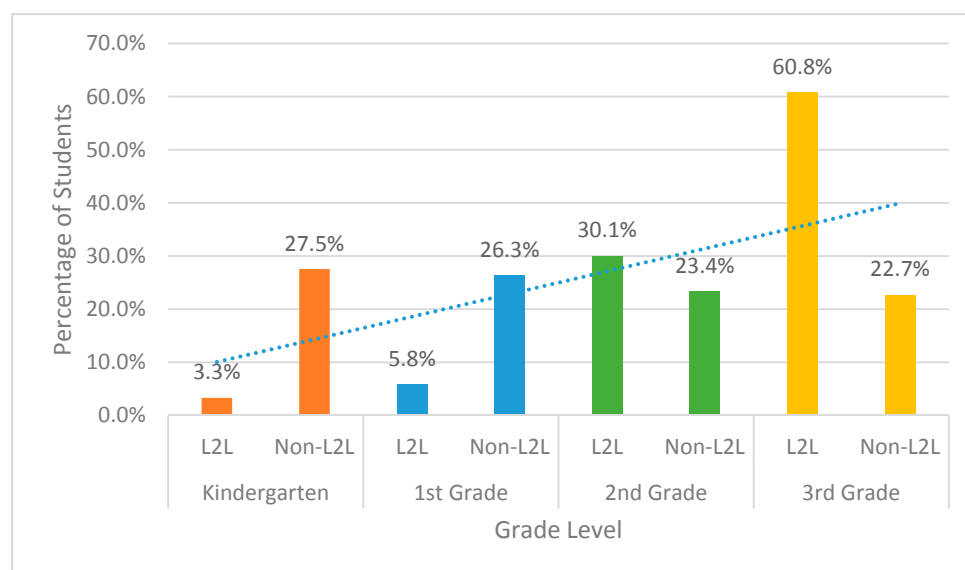


Figure 4. Comparison participation by grade.

3. Results

3.1. Implementation Fidelity

76% of students had accounts for L2L created by the end of September and the remaining accounts were added throughout the school year. Use of L2L also varied by month. L2L defines program fidelity as completing three lessons per week with quiz scores for each lesson at 80% and above. This equates to approximately completion of a hundred lessons during the school year for each student to meet fidelity. L2L developers set this as fidelity for program implementation as three lessons completed independently each week during reading centers is the intended design for L2L implementation to integrate feasibly into most classroom's one-week planning schedules and required very little management by the teacher. On average, students completed 40 lessons, most of which were between September and February of 2017 (Figure 5) likely due to common interruptions (breaks and testing periods) in the academic calendar.

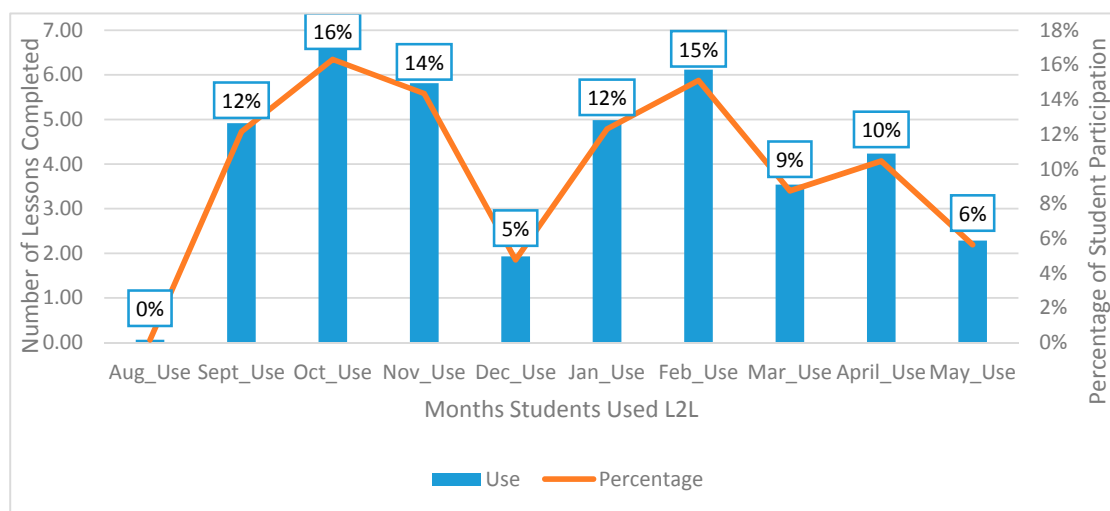


Figure 5. Average lessons completed and percentage completion by month.

Most students used L2L less than 50 times, while only 5% used it with fidelity (completed more than 101 quizzes over the year scoring 80% or higher) (Figure 6).

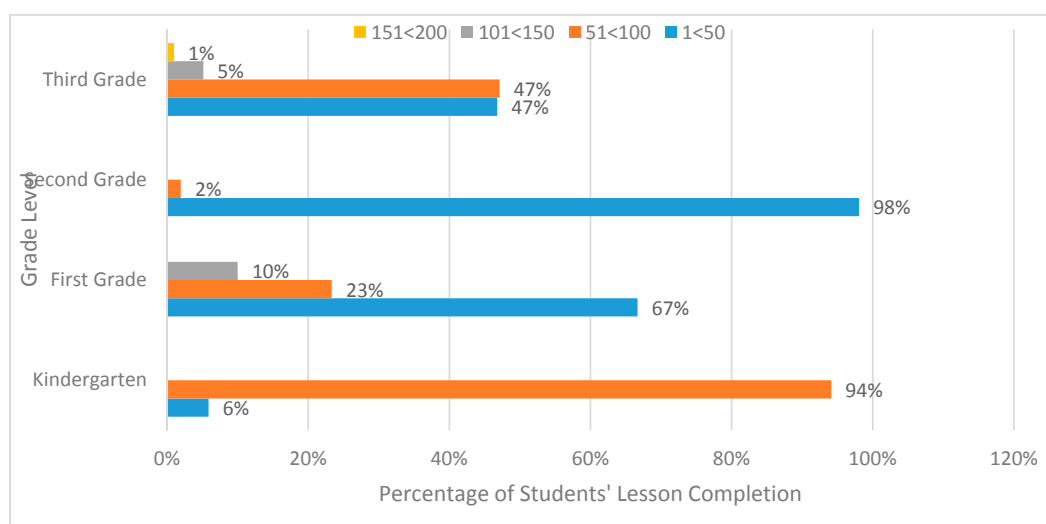


Figure 6. Lessons completed on L2L by grade.

3.2. Research Questions

To address the research questions for the current study propensity score matching was utilized [46]. Gender, minority status, free and reduced lunch status, special education status, and Fall reading scores were used as the covariates to calculate propensity scores. The propensity score was then used to match students who used L2L with those that did not. The difference in both the DIBELS and Galileo assessments between groups could then be considered the impact of the intervention on students using Lyrics2Learn. It should be noted that this approach cannot account for unknown interventions that students in the matched group may have received. Because all students naturally had statistically significant increases in test scores between Fall and Spring, using the propensity score approach allows for a closer analysis of the true impact of the intervention on student outcomes in reading performance.

Q1. Does using Lyrics2learn accelerate reading comprehension improvement for K–third grade students?

3.3. CMAS/PARCC Performance

When matched by covariates, students performed similarly to non-L2L peers (Table 5). Usage of L2L varied across schools and grades. Again, the recommended usage of L2L is the completion of three lessons per week. As mentioned previously, many classrooms did not use L2L with this level of fidelity. The following analysis further investigates students that used L2L with some regularity approaching fidelity (100 over the school year). The analysis looks at students that completed 60, 75, or 90 lessons. Regardless of how much students used L2L they still performed comparably to their matched counterparts (Table 5). However, it is of interest to note that as students approach use with fidelity (100 lessons or more) the differential between L2L and comparison students grows larger. Students completing 90 lessons or more of L2L had an average score of 892 on the spring reading assessment compared to 864 of their non-L2L matched counterparts.

Table 5. Mean scores after matching including use.

Grade	Fall Reading			Spring Reading		
	Comparison	L2L	<i>p</i> -Value	Comparison	L2L	<i>p</i> -Value
First	580.46	576.108	0.821	676.216	658.676	0.241
Second	591.865	592.46	0.948	696.212	695.957	0.982
Third	745.349	747.395	0.757	816.551	815.506	0.902
Third—Use 60	774.709	776.427	0.859	850.192	863.974	0.233
Third—Use 75	790.991	787.25	0.796	865.25	860.268	0.79
Third—Use 90	797.976	804.619	0.77	863.571	892.238	0.315

Q2. Does using Lyrics2learn accelerate reading fluency improvement for K–third grade students?

3.4. DIBELS Performance

After matching, students performed similarly in the Fall, as Fall DORF and RETELL were used as covariates to match. When matched using propensity scores, second and third grade students using L2L performed similarly to their non-L2L counterparts on oral reading fluency (DORF)). However, they did not perform as well as their non-L2L counterparts in RETELL or overall Composite scores for second and third grade (Table 6). Usage of L2L varied across schools and grades. Again, the recommended usage of L2L is the completion of three lessons per week. As mentioned previously, many classrooms did not use L2L with this level of fidelity. The following analysis further investigates students that used L2L with some regularity approaching fidelity (100 over the school year). The analysis looks at students that completed 60, 75, or 90 lessons. Regardless of L2L usage, after propensity score matching students perform similarly on DORF and slightly lower on RETELL and composite scores (Table 6).

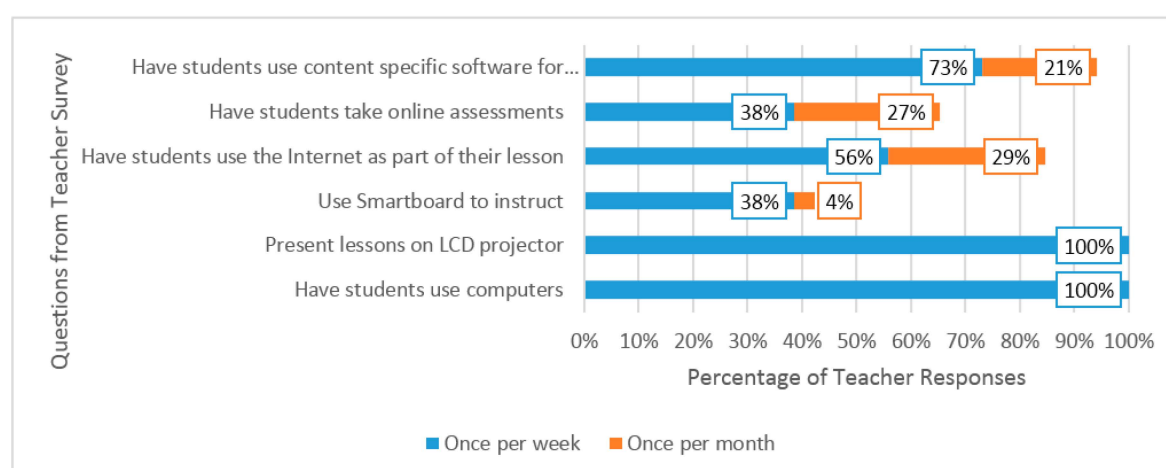
Table 6. Mean DORF and RETELL spring scores after matching including use.

Grade	DORF Spring			RETELL Spring			Composite Spring		
	Comp	L2L	<i>p</i> -Value	Comp	L2L	<i>p</i> -Value	Comp	L2L	<i>p</i> -Value
Kinder	-	-	-	-	-	-	144.824	140.177	0.719
First	-	-	-	-	-	-			
Second	96.365	95.461	0.268	42.418	38.618	0.032	281.145	263.046	0.051
Third	96.813	96.475	0.388	50.01	45.02	0.001	386.702	365.682	0.01
Third—Use 60	98.035	98.07	0.897	53.909	47.452	0.001	423.157	394.504	0.005
Third—Use 75	97.926	97.963	0.918	48.519	44.796	0.21	396.528	382.556	0.359
Third—Use 90	98.476	98.476	1	53.857	42.238	0.014	428.381	389.381	0.098

Note: Significant at the $p < 0.05$ level.

Q3. Does use of Lyrics2Learn impact teacher practices?

On the teacher perception survey, L2L teachers reported integrating technology into their instruction on a weekly basis. Methods of technology integration reported by teachers in the current study include integrating SMART boards in instruction, having students use the Internet as part of a lesson, or take online assessments (Figure 7).

**Figure 7.** Teachers' reported integrated technologies.

Teachers also reported increasing their technology skill level over the school year, moving from the basic category into the proficient and advanced categories (Figure 8). The survey administered to teachers in both the fall and spring asked teachers to rate themselves on a proficiency scale starting with "unable" through "advanced" on a series of four questions relating to using, implementing, and integrating technology as a tool or resource in the classroom. Overall, between the pre- and post-test of teacher self-assessment of technology use, teachers reported an increase in capacity to plan, integrate, use and implement technology based tools. In Figure 6, note the percentage of teachers self-reporting as unable, learner or basic in the fall (pre), as compared to the percentage of teachers reporting as proficient or advanced in the four outlined content areas of technology use in the spring (post). While this does not indicate that using L2L increased teacher's technology proficiency, it is worth noting on the end of the year survey 91% of teachers agree that L2L enhanced their proficiency at using technology to individualize learning (Figure 12).

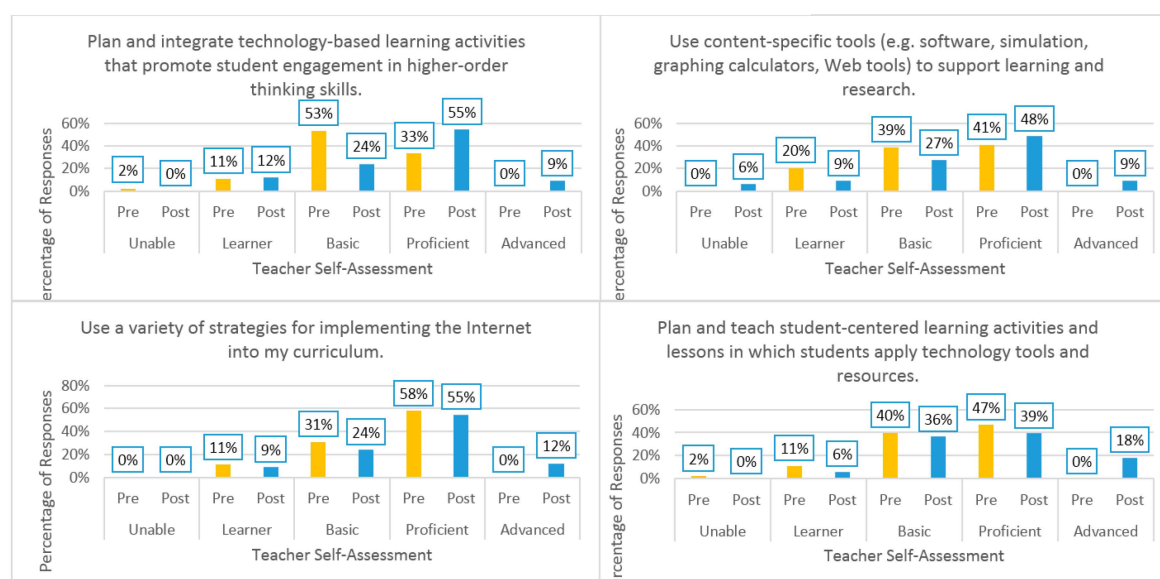


Figure 8. Teacher self-assessment of technical aptitude.

Most teachers reported being able to access technology when needed, felt confident in abilities to integrate technologies and have a variety of ideas and lessons for technological integration with teaching. Teachers seemed to diverge in their perception of the amount of time needed to prepare technology-based lessons (Figure 9).

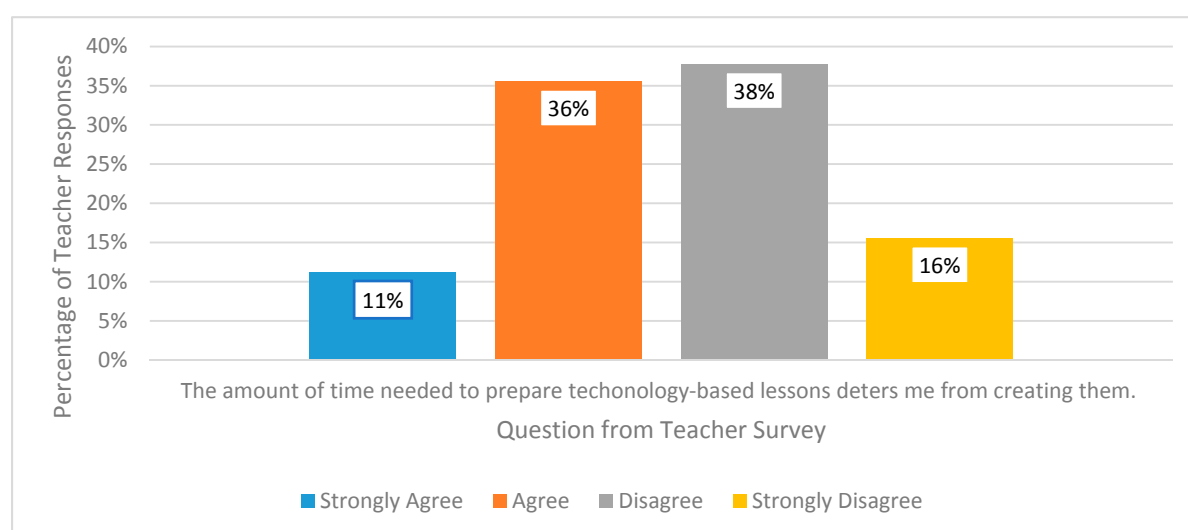


Figure 9. Teachers' reported technology integration perception.

Q4. Does Lyrics2learn increase student classroom engagement, participation, and motivation?

At the beginning of the school year teachers reported generally high levels of engagement for their students not only during literacy instruction but also outside of literacy (Figure 10). However, at the end of the school year, teachers more strongly agreed that students were engaged when using L2L compared to other literacy instruction they engaged in at the beginning of the school year.

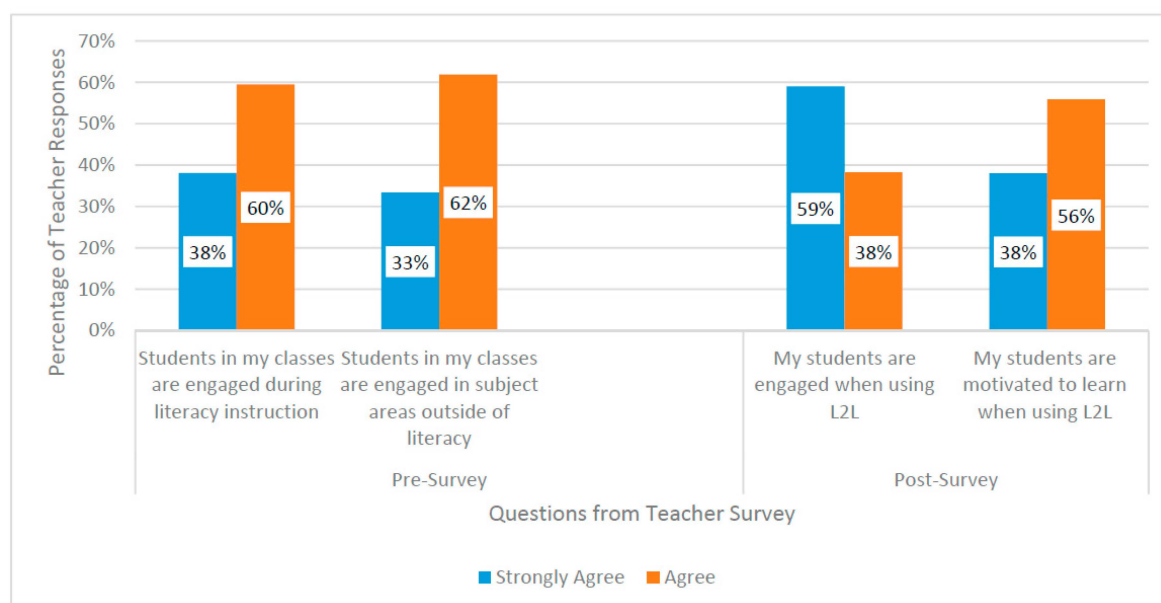


Figure 10. Teachers' perceptions on student subject engagement.

Additionally, all teachers agree that students find L2L easy to use and the stories are interesting (Figure 11).

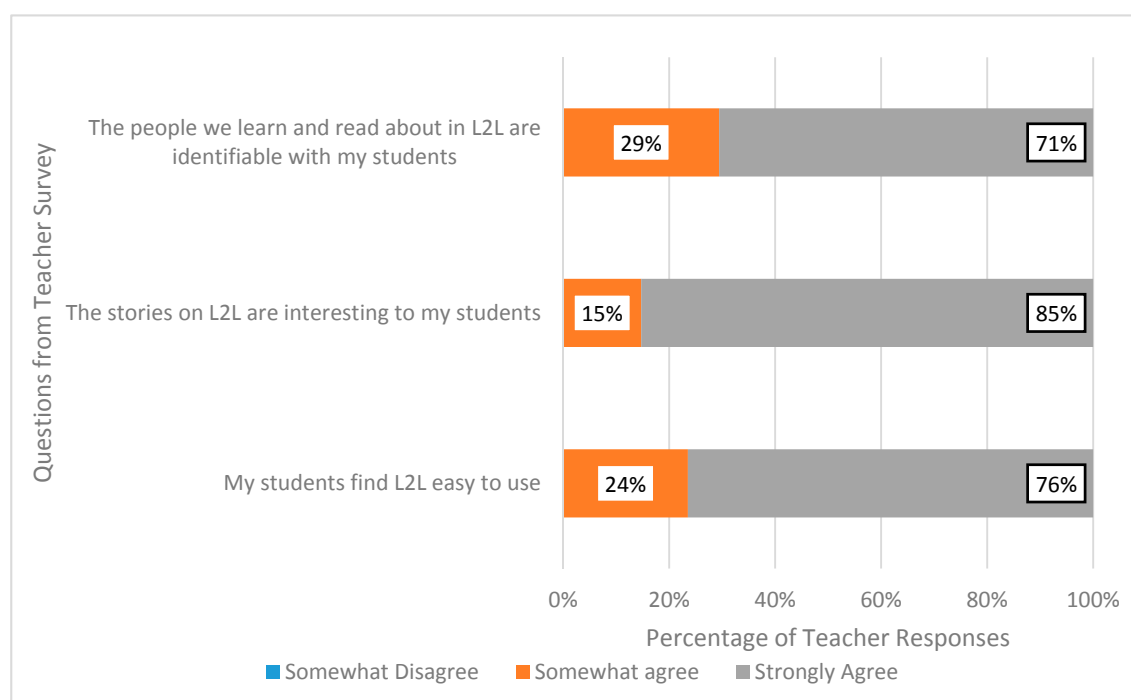


Figure 11. Teachers' responses for L2L student use.

3.5. Teacher Perceptions of L2L

In general, teachers reported that L2L is relevant to the work that they do and easy to use. Moreover, 100% would recommend L2L to a colleague. However, teachers did not always find the weekly resource emails helpful and L2L was not always easy to plan into reading lessons. Figure 12 below provides the overall responses for each statement. Teachers appreciated the ease of use of L2L

and its adaptability to student needs. Teachers also reported liking the personalized student reports, while others thought that reports are an area that could be improved upon making it more accessible and navigable for teachers.

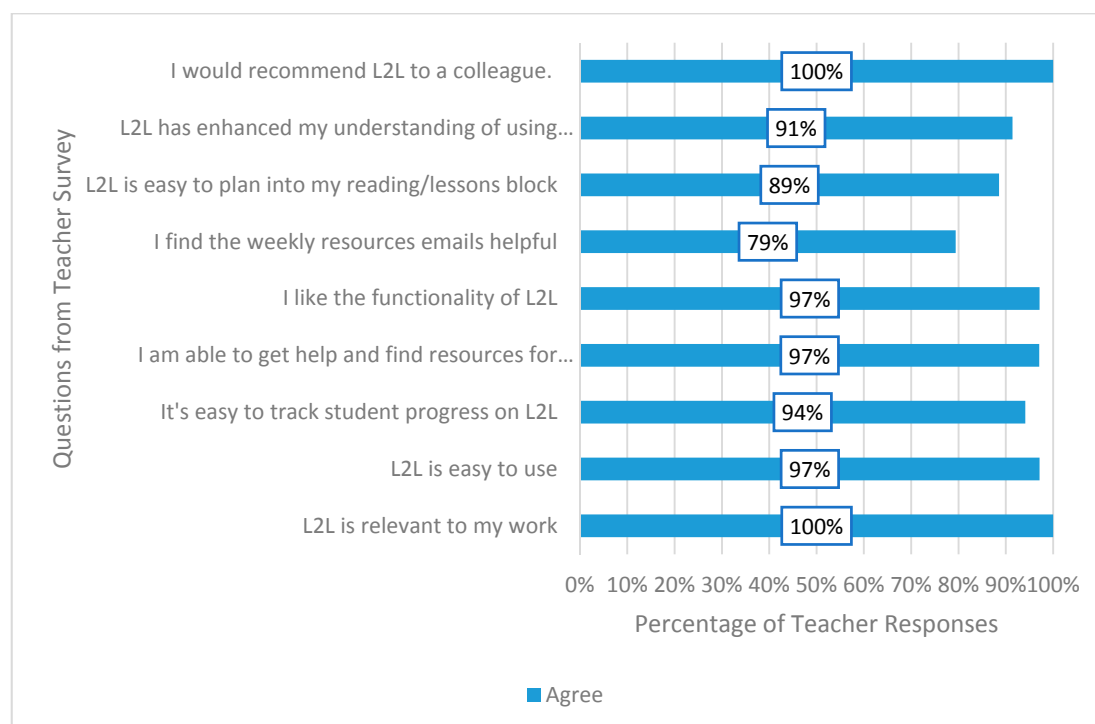


Figure 12. Teachers' responses for L2L use.

However, all features on L2L are not viewed equally. Teachers found the “leveled comprehension” part of L2L the most useful, with “fluency videos” and “class scores and data” also being extremely useful. Also, about half of the teachers surveyed reported not using “L2L Worksheets”, and a third reported not using “tutorial videos” (Figure 13).

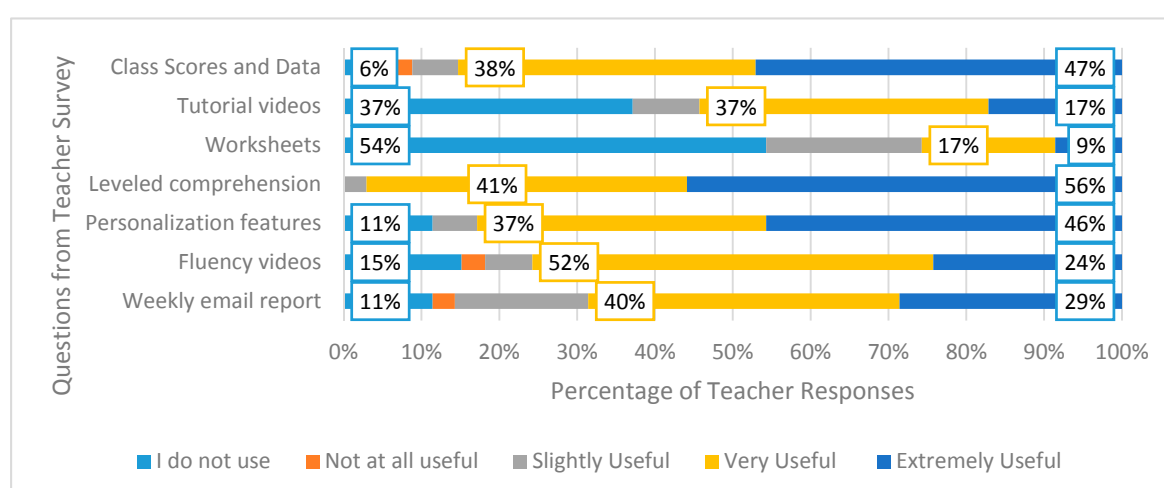


Figure 13. Teachers' responses for L2L features.

4. Discussion

Lyrics2learn (L2L) aims to address the disparities that currently exist among up to one-third of students in the United States who perform below proficient reading levels and help those already achieving benchmark to exceed expectations. The current study explored the potential of a new reading application, L2L, on student reading achievement. The current study found, after matching L2L and non-L2L students, there were no statistically significant differences on student achievement measures. However, a significant limitation of the current study is that it did not capture potential literacy interventions used in L2L or comparison classrooms. This significant limitation could be an explanation for the lack of variability between the groups. As previously stated, the school district utilizes Wonders as its main literacy curriculum, with each school organizing literacy instruction in slightly different ways. We also know from the teacher survey that L2L teachers utilized the tool in different ways as well, but primarily for instructional centers, thus it was likely that the majority of their literacy instruction time was still utilizing Wonders. In general, much more needs to be understood regarding the instructional practices of the L2L and non-L2L classrooms before stronger conclusions can be made. Future studies of L2L should gather more information on the literacy interventions used in comparison classrooms to better understand L2L's potential impact on student achievement.

Additionally, more investigation is warranted to understand why so few teachers implemented L2L with fidelity. Even though time requirements to implement Lyrics2Learn are relatively low (15 min per day, three times per week), fidelity levels in this district may have been low due to tools and curricula (Wonders) already available and encouraged by district administration. Though L2L was approved for the by school and district leadership for the study, district curriculum leaders were not actively involved to aid in implementation. Recent studies have examined and identified specific predictors of implementation of interventions in schools, such as administrator support, consistent funding, ongoing professional development, practice efficiency, staff stability, teaming, and use of data for decision making [9,10,48,49]. Recent randomized controlled effectiveness trials of school-wide practices have shown more rapid implementation (i.e., the vast majority of schools meeting criteria for implementation in their first year) when there is strong organizational health and district support [50,51]. The current study did not collect information on these specific predictors of implementation to be able to understand to what extent they may have played a role in fidelity. Additionally, there is evidence to suggest that intervention fidelity growth is generally faster in the second year of implementation than the first [52]. Future studies should examine these predictors of implementation and sustainability of L2L and patterns of implementation over time.

Though L2L did not yield significant student outcomes, it is still worthwhile to note the perceptions of L2L teachers regarding ease of use of the web-based tool. This is important to note, as educational technology is more and more a part of everyday classroom instruction. However, to realize fully the benefits of technology in our classrooms, educators need to be able to use technology effectively in their practice. Teacher preparation programs and many professional development systems include training on educational technology applications. Yet many new teachers still feel unprepared to use technology to support student learning as they transition to teaching and using technology effectively in the classrooms [11]. Additionally, many traditional reading interventions require significant days of staff time and professional development that often includes significant financial investments. On the other hand, L2L requires no lengthy training and at a fraction of the cost. With very little preparation time, L2L teachers indicated that the software was easy to use, and all would recommend L2L to a colleague.

Educational technology such as L2L has the opportunity to allow teachers to customize assessments and instruction to individual students in real-time. L2L includes customizable assessments; however, a limitation of the current study is that L2L does not currently collect user analytics on which components of L2L are used. In the future it would be important to understand the extent to which teachers access the rapid reporting formative assessment feature of L2L to inform their instructional

practices. This information could provide compelling information to further the research base in support of technology tools in the classroom.

With further study, L2L holds promise to demonstrate the benefits of technology interventions for reading achievement, and how technology can and should build upon what research supports as effective practice. L2L builds off of effective strategies for teaching reading comprehension and fluency by individualizing instruction with technology. L2L does not alter ‘what’ we should be teaching, but instead enhances ‘how’ we should be teaching. The development of L2L exemplifies how schools are incubators of innovation. L2L started as the idea of a classroom teacher who saw a need in his classroom and identified a solution.

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References

1. Miller, E.; Almon, J. *Crisis in the Kindergarten: Why Children Need to Play in School*; Alliance for Childhood: College Park, MD, USA, 2009.
2. Isaacs, J.B. *Starting School at a Disadvantage: The School Readiness of Poor Children*; Center on Children and Families at Brookings Institution: Washington, DC, USA, 2012.
3. National Center for Education Statistics. *NAEP 2009 High School Transcript Study*; National Center for Education Statistics: Washington, DC, USA, 2009.
4. National Center for Education Statistics. *Condition of Education 2011*; National Center for Education Statistics: Washington, DC, USA, 2011.
5. Jensen, E. *Teaching with the Brain in Mind*. Association for Supervision; Curriculum Development: Alexandria, VA, USA, 2005.
6. Deboer, G.E. Student-centered teaching in a standards-based world: Finding a sensible balance. *Sci. Educ.* **2002**, *11*, 405–417. [CrossRef]
7. Kersten, J.; Pardo, L. Finessing and hybridizing: Innovative practices in Reading First classrooms. *Read. Teach.* **2007**, *61*, 146–154. [CrossRef]
8. Literacy Centers. Just Read, Florida! Retrieved from Reading Rockets. Available online: <http://www.readingrockets.org/article/literacy-centers> (accessed on 27 May 2018).
9. McIntosh, K.; Mercer, S.H.; Hume, A.E.; Frank, J.L.; Turri, M.G.; Mathews, S. Factors related to sustained implementation of schoolwide positive behavior support. *Except. Child.* **2013**, *79*, 293–311.
10. Sanford DeRousie, R.M.; Bierman, K.L. Examining the sustainability of an evidence-based preschool curriculum: The REDI program. *Early Child. Res. Q.* **2012**, *27*, 55–65. [CrossRef] [PubMed]
11. U.S. Department of Education, Office of Educational Technology. *Reimagining the Role of Technology in Education: 2017 National Education Technology Plan Update*; U.S. Department of Education, Office of Educational Technology: Washington, DC, USA, 2017.
12. Shaywitz, S.E.; Shaywitz, B.A. Armed with the facts: The science of reading and its implications for teaching. In *Why Kids Can't Read: Challenging the Status Quo in Education*; Blaustein, P., Lyon, R., Eds.; Rowan and Littlefield: Toronto, ON, Canada, 2006; pp. 9–29.
13. Hasbrouck, J.; Glaser, D.R. *Reading Fluency: Teaching and Understanding This Complex Skill*; Gibson Hasbrouck: Wellesley, MA, USA, 2012; Available online: www.gha-pd.com (accessed on 27 May 2018).
14. Rasinski, T.; Hamman, P. Fluency: Why it is “not hot”. *Read. Today* **2010**, *28*, 26.
15. National Institute of Child Health and Human Development. *Report of the National Reading Panel. Teaching Children to Read: An Evidence-Based Assessment of the Scientific Research Literature on Reading and Its Implications for Reading Instruction* (NIH Publication No. 004769); U.S. Government Printing Office: Washington, DC, USA, 2000.

16. Rasinski, T.V.; Reutzel, C.R.; Chard, D.; Linan-Thompson, S. Reading fluency. In *Handbook of Reading Research*; Kamil, M.L., Pearson, P.D., Moje, B., Afflerbach, P., Eds.; Routledge: New York, NY, USA, 2011; Volume IV, pp. 286–319.
17. Rasinski, T.; Blachowicz, C.L.Z.; Lems, K. (Eds.) *Fluency Instruction, Second Edition: Research-Based Best Practices*; Guilford Press: New York, NY, USA, 2012.
18. Kuhn, M.; Stahl, S. Fluency: A review of developmental and remedial practices. *J. Educ. Psychol.* **2003**, *95*, 3–21. [[CrossRef](#)]
19. Pluck, M. Rainbow Reading Programme: Using taped stories. *Read. Forum* **1995**, *1*, 25–29.
20. Topping, K. *Paired Reading, Spelling, and Writing*; Cassell: New York, NY, USA, 1995.
21. Nalder, S.; Elley, W. Using Audio-Taped Read along Stories with Low-Progress Readers. 2003. Available online: rainbowreading.org.nz/wp.../08/audio-taped-read-along-stories.pdf (accessed on 1 March 2016).
22. Rasinski, T.; Zimmerman, B.; Bagert, B. Poetry as a Core Reading Text for Younger and Struggling Readers. *N. Engl. Read. Assoc. J.* **2015**, *51*, 1–5.
23. Zimmerman, B.; Rasinski, T. The fluency development lesson: A model of authentic and effective fluency instruction. In *Fluency Instruction*, 2nd ed.; Rasinski, T., Blachowicz, C., Lems, K., Eds.; Guilford: New York, NY, USA, 2012; pp. 172–184.
24. Therrien, W.J. Fluency and comprehension gains as a result of repeated reading: A meta-analysis. *Remedial Spec. Educ.* **2004**, *25*, 252–261. [[CrossRef](#)]
25. Lamb, S.J.; Gregory, A.H. The relationship between music and reading in beginning readers. *Educ. Psychol.* **1993**, *13*, 19–27. [[CrossRef](#)]
26. Bolduc, J. The effects of music instruction on emergent literacy capacities among preschool children: A literature review. *Early Childhood Research & Practice*; 2008. Available online: <https://eric.ed.gov/?id=EJ967474> (accessed on 18 June 2018).
27. Patel, P.; Laud, L.E. Using Songs to Strengthen Reading Fluency. *Teach. Except. Child. Plus* **2007**, *4*. Available online: <https://eric.ed.gov/?id=EJ967474> (accessed on 20 June 2018).
28. Rasinski, T.V. Reading fluency instruction: Moving beyond accuracy, automaticity, and prosody. *Read. Teach.* **2006**, *59*, 704–706. [[CrossRef](#)]
29. Sample, K.J. Promoting fluency in adolescents with reading difficulties. *Interact. Sch. Clin.* **2005**, *40*, 243–246. [[CrossRef](#)]
30. Standley, J. Does music instruction help children learn to read? Evidence of a meta-analysis. *Update Appl. Res. Music Educ.* **2008**, *27*, 17–32. [[CrossRef](#)]
31. Towell, J.H. Teaching reading: Motivating students through music and literature. *Read. Teach.* **1999**, *53*, 284–289.
32. Moorehead-Carter, Y.M. The Impact of Singing-Integrated Reading Instruction on the Oral Reading Fluency and Motivation of Elementary Students in an Out-of-School Time Program. Ph.D. Thesis, Virginia Commonwealth University, Richmond, VA, USA, 2015.
33. Rasinski, T.V. Why reading fluency should be hot! *Read. Teach.* **2012**, *65*, 516–522. [[CrossRef](#)]
34. Lyrics2Learn. Improved Reading Comprehension and Reading Fluency Results Using L2L. 2016. Available online: <https://www.lyrics2learn.com/results.html> (accessed on 20 February 2018).
35. Good, R., III; Kaminski, R.A. *What Are DIBELS? Dynamic Indicators of Basic Early Literacy Skills*; Dynamic Measurement Group, Inc.: Eugene, OR, USA, 1988; Available online: <https://dibels.org/dibels.html> (accessed on 25 February 2018).
36. Dynamic Measurement Group. Getting Started with DIBELS. 2017. Available online: <https://dibels.org/GettingStartedWithDIBELS.pdf> (accessed on 25 February 2018).
37. Harlacher, J. *An Educator's Guide to Questionnaire Development (REL 2016–108)*; U.S. Department of Education, Institute of Education Sciences, National Center for Education Evaluation and Regional Assistance, Regional Educational Laboratory Central: Washington, DC, USA, 2016. Available online: <http://ies.ed.gov/ncee/edlabs> (accessed on 12 September 2016).
38. Colorado Department of Education. CMAS-Mathematics, English Language Arts, Science, and Social Studies. Available online: <https://www.cde.state.co.us/assessment/newassess-parcc-archive> (accessed on 23 February 2018).
39. Burgess, T.F. *A General Introduction to the Design of Questionnaires for Survey Research*; University of Leeds: Leeds, UK, 2001. Available online: <http://iss.leeds.ac.uk/downloads/top2.pdf> (accessed on 1 September 2014).

40. Fink, A. *How to Conduct Surveys: A Step-by-Step Guide*; Sage Publications: Thousand Oaks, CA, USA, 2013.
41. Dillman, D.A. *Internet, Mail, and Mixed-Mode Surveys: The Tailored Design Method*; Wiley: New York, NY, USA, 2014.
42. Check, J.; Schutt, R.K. *Research Methods in Education*; Sage Publications: Thousand Oaks, CA, USA, 2012.
43. Phellas, C.N.; Block, A.; Seale, C. Structured methods: Interviews, questionnaires, and observation. In *Researching Society and Culture*, 3rd ed.; Seale, C., Ed.; Sage Publications: Thousand Oaks, CA, USA, 2012; pp. 181–205.
44. Pope, P.; Boleman, C.; Cummings, S. *Questionnaire Design: Asking Questions with a Purpose*; Texas A&M AgriLIFE Extensions Service: College Station, TX, USA, 2005; Available online: <http://agrifecdn.tamu.edu/od/files/2010/04/Questionnaire-Design-Publication-E-227.pdf> (accessed on 12 September 2014).
45. Thorndike, R.M.; Thorndike-Christ, T. *Measurement and Evaluation in Psychology and Education*, 8th ed.; Pearson: Boston, MA, USA, 2010.
46. Guo, S.; Fraser, M.W. *Propensity Score Analysis: Statistical Methods and Applications*; SAGE Publications: Thousand Oaks, CA, USA, 2015.
47. McGraw Hill Education. Wonders: The Power of Connected Programs. 2018. Available online: <https://www.mheducation.com/prek-12/program/microsites/MKTSP-BGA04M0.html> (accessed on 20 February 2018).
48. Baker, S.; Gersten, R.; Dimino, J.A.; Griffiths, R. The sustained use of research-based instructional practice: A case study of peer-assisted learning strategies in mathematics. *Remedial Spec. Educ.* **2004**, *25*, 5–24. [CrossRef]
49. Hunter, S.B.; Han, B.; Slaughter, M.E.; Godley, S.H.; Garner, B.R. Associations between implementation characteristics and evidence-based practice sustainment: A study of the adolescent community reinforcement approach. *Implement. Sci.* **2015**, *10*, 173. [CrossRef] [PubMed]
50. Bradshaw, C.P.; Koth, C.W.; Thornton, L.A.; Leaf, P.J. Altering school climate through school-wide positive behavioral interventions and supports: Findings from a group-randomized effectiveness trial. *Prev. Sci.* **2009**, *10*, 100–115. [CrossRef] [PubMed]
51. Horner, R.H.; Sugai, G.; Smolkowski, K.; Eber, L.; Nakasato, J.; Todd, A.W.; Esparanza, J. A randomized, wait-list controlled effectiveness trial assessing school-wide positive behavior support in elementary schools. *J. Posit. Behav. Interv.* **2009**, *11*, 133–144. [CrossRef]
52. Schaper, A.; McIntosh, K.; Hoselton, R. Within-year fidelity growth of SWPBIS during installation and initial implementation. *Sch. Psychol. Q.* **2016**, in press. [CrossRef] [PubMed]



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