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Exploring the Effect of Rhythmic Interventions on First- and Second-Grade Music Students' Oral Reading Fluency

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Abstract

The purpose of this study was to explore the effect of rhythmic interventions (e.g., steady beat, rhythm production, and rhythm discrimination activities) on oral reading fluency scores of first- and second-grade music students. This study was guided by the following research questions: (1) What is the psychometric quality of the Dynamic Indicators of Basic Early Literacy Skills (DIBELS) used in the context of measuring the oral reading fluency of first- and second-grade general music students? (2) What is the effect of rhythmic interventions on first- and second-graders' oral reading fluency scores? and (3) What is the interaction effect between rhythmic interventions and fluency achievement? Participants included two first-grade and two second-grade elementary music classes (N = 72; male, n = 37; female, n = 35). Participants were randomly assigned into control and treatment groups in each class for first-grade (N = 34; control, n = 17; treatment, n = 17) and second-grade (N = 38; control, n = 19; treatment, n = 19). All participants were administered the Dynamic Indicators of Basic Early Literacy Skills (DIBELS) to measure oral reading fluency ability as a pretest and posttest. Treatment groups underwent rhythmic interventions throughout seven, 45-minute sessions. After controlling for differences in students' pretest scores, results indicated an overall statistically significant treatment effect for first-grade students and a statistically significant interaction effect for the core grouping of second-grade students. The researchers discuss Implications for implementation and advocacy.

Keywords: fluency, general music, Rasch, reading, rhythm

Research suggests that rhythmic ability is strongly correlated to phonological awareness in young children (Anvari, Trainor, Woodside, & Levy, 2002; Atterbury, 1985; Bryant, Bradley, Maclean, & Crossland, 1989; Douglas & Willatts, 1994; Forgeard et al., 2008; Gordon et al., 2015; Moritz, Yampolsky, Papadelis, Thomson, & Wolf, 2013; Overy, 2003), and the skills acquired through music participation may transfer to improved reading skills (Bugaj & Brenner, 2011; Corrigall & Trainor, 2011; Long, 2014; Moreno, Friesen, & Bialystok, 2011; Thiele, 2016; Tsang & Conrad, 2011). Over fifty years ago, Drake (1964) noted that "it has become apparent that the development of rhythm is intimately related to the acquisition of reading, writing, and spelling skills" (p. 202). More recently, functional magnetic resonance imaging (fMRI) studies demonstrated that the processing of rapid temporal information that develops our listening and

language skills occurs in the left-hemisphere of the brain (Forgeard et al., 2008, p. 383). As Forgeard and colleagues noted, the rate at which auditory information processing occurs may impact music and reading abilities. For example, if the time period required to process an auditory signal is too long, it becomes difficult to comprehend or respond accordingly. Thiele (2016) suggested that similar auditory skills are used for language processing, reading, rhythmic discrimination, and rhythm production, whereby "near transfer occurs when the abilities acquired for one skill advances the abilities in another closely associated skill" (p. 53). Therefore, focused attention on improving young children's rhythmic skills may improve both language and reading skills.

Patel's (2011) OPERA (Overlap, Precision, Emotion, Repetition, and Attention) hypothesis suggests that musical training benefits the neural encoding of speech when five conditions are met. These five conditions, specifically driven by adaptive plasticity in speech-processing networks, include: (a) *overlap*- there is anatomical overlap in the brain networks that process an acoustic feature used in both music and speech (e.g., waveform periodicity, amplitude envelope), (b) *precision of processing*- music places higher demands on these shared networks than does speech, (c) *emotion*- the musical activities that engage this network elicit strong positive emotion, (d) *repetition*- the musical activities that engage this network are frequently repeated, and (e) *attention*- the musical activities that engage this network are associated with focused attention. Both music and speech use pitch, rhythmic timing, and timbre to convey information. Therefore, processing these cues through music training may potentially enhance their processing in the context of speech (Patel, 2011). However, it is important to note that music processing does not automatically meet these five conditions. Patel argues that it has the potential to meet these conditions depending on what acoustic features are being emphasized in

training, the demands that music places on those features in terms of the precision of processing, and the degree of emotional reward, repetition, and attention associated with the musical activities.

Reading Ability and Rhythmic Skills

In the context of music education, two early studies address the association between reading ability and rhythmic skills. Atterbury (1985) examined over 90 children (ages seven and eight) throughout two trials. Atterbury classified participants as "normal-achieving" and "learning-disabled" readers and tested them on rhythm discrimination, and rhythm performance (e.g., echo-clapping). Results indicated that "normal achieving" readers performed the rhythm tasks better than the matched "learning-disabled" sample. Douglas and Willatts (1994) examined 78 seven- and eight-year-old children for comparisons in pitch-discrimination tasks (e.g., higher, lower, or same) and rhythm discrimination tasks (e.g., respond “same” or “different” to pairs of sequences played on a woodblock) with various vocabulary, reading, and spelling tests. Results of this study indicated that rhythm discrimination was significantly related to reading ability.

Anvari, Trainor, Woodside, and Levy (2002) found similar results in a study of 100 four- and five-year-old children. They included rhythm discrimination and rhythm production tasks, among other language and mathematical tests. Results of their study suggested that music perception skill is related to both phonological awareness and early reading development. A longitudinal study of rhythm and reading development revealed that student’s rhythmic abilities in first-grade significantly predicted their reading ability up into fifth grade (David, Wade-Woolley, Kirby, & Smithrim, 2007). More recent studies also continue to support these findings. Moritz, Yampolsky, Papadelis, Thomson, and Wolf (2013) examined 30 kindergarteners from two schools and found mild positive relations between phonological awareness and rhythm

ability. Furthermore, Gordon, Shivers, Wieland, Kotz, Yoder, and McAuley (2015) examined the rhythm and reading skills of 25 children aged five to seven. The study indicated that high scorers on the phonological awareness measure discriminated complex rhythms better than low scores and a composite score of the rhythmic measures accounted for 48% of the variance in grammar skill performance.

Similar to reading, rhythm uses a sound-to-symbol system that requires auditory discrimination and visual tracking (Butzlaff, 2000). The motivation for this study was to investigate if this suggested relationship affects the teaching and learning of reading, or more specifically, oral reading fluency. Oral reading fluency is operationally defined as "a direct measure of phonological segmentation and recoding skill as well as rapid word recognition" (Fuchs, Fuchs, Hosp, & Jenkins, 2001, p. 241). Fuchs et al. suggest that

> oral reading fluency represents a complicated, multifaceted performance. Itentails, for example, a reader's perceptual skill at automatically translating letters into coherent sound representations, unitizing those sound components into recognizable wholes and automatically accessing lexical representations, processing meaningful connections within and between sentences, relating text meaning to prior information, and making inferences to supply the missing information. (pp. 239-240)

Previous research investigating the relationship between musical training and reading skills often explore normal-reading children and/or children with reading difficulties, such as dyslexia. However, the relationship between oral reading fluency and music training is somewhat unclear.

Oral Reading Fluency and Music Training

Forgeard, Schlaug, Norton, Rosam, Iyengar, and Winner (2008) suggest that music intervention may strengthen the auditory music perception skills of children with dyslexia, and

could possibly “remediate some of their language deficits” (p. 383). However, the measures in this study focused on phonological skills, a picture-vocabulary test, letter and word identification tasks, and other related tasks. Tsang and Conrad (2011) studied a larger sample size ($N = 70$) of children between the ages of five and nine and found that musically trained children (e.g., formal music lessons) outperformed musically untrained children (e.g., no-formal music lessons) on the measures of pitch discrimination, rhythm discrimination, and phonological skills. However, the two groups performed similarly on tests of word identification, timbre discrimination, and receptive vocabulary. Comparably, Corrigall and Trainor (2011) investigated whether the length of time children took music lessons was associated with word decoding and reading comprehension skills for 46 children that are normal-achieving readers ranging in age from six to nine. They indicated a robust association between length of music training and reading comprehension. Moreno, Friesen, and Bialystok (2011) found similar results with a sample size of 60 children between the ages of four and six over 4 weeks. However, the study investigated the effect of music and art training on intelligence tests, phonological awareness, and rhyming tests. They observed greater improvement following training in the music group. Although all of these studies suggest promising results, they did not include oral reading fluency as a measure for comparison.

Long (2014) studied 15 children (ages nine and ten) deemed as "weak readers" (p. 110) who participated in 10 minutes of rhythm-based exercises at the start of their weekly music lessons over a 6-week intervention period. Results revealed statistically significant changes with substantial gains in reading behavior with large effect sizes in reading comprehension and rate (fluency) and a medium effect size in reading accuracy. However, with such a small sample size, it is difficult to generalize these findings. The second study conducted by Thiele (2016) consisted

of 214 third grade students that were screened for their rhythmic and reading abilities. Students that were classified as at-risk readers and demonstrated rhythmic deficiencies were selected to participate in the study. Only 12 students qualified to participate in the rhythm classes that consisted of 17 sessions over 27 weeks. Results suggested that strengthening at-risk readers rhythmic abilities may improve reading skills to varying degrees.

While research suggests that experience with music training or music interventions can be beneficial to improving young children's reading abilities (Corrigall & Trainor, 2011; Long, 2014; Moreno et al., 2011; Thiele, 2016; Tsang & Conrad, 2011), many of these studies are limited in scope. For example, Thiele (2016) and Long (2014) did not compare normal-reading children in their rhythmic interventions. Also, the measure of oral reading fluency, an indicator of overall reading competence (Fuchs et al., 2001), is scarcely compared against rhythmic intervention data. Rather, other comparative reading measures are emphasized such as word identification and passage comprehension tests (Corrigall & Trainor, 2011), a vocabulary test to measure verbal intelligence (Moreno et al., 2011), or a phonological assessment (Tsang & Conrad, 2011). The purpose of this study was to explore the effect of rhythmic interventions (e.g., keeping a steady beat, rhythm discrimination, and rhythm production activities) on oral reading fluency scores of first- and second-grade music students with varying rhythm and reading abilities. The research questions that guide this study include:

1. What is the psychometric quality of the Dynamic Indicators of Basic Early Literacy Skills (DIBELS) used in the context of measuring the oral reading fluency of first- and second-grade general music students?
2. What is the effect of rhythmic interventions on first- and second-graders' oral reading fluency scores?

3. What is the interaction effect between rhythmic interventions and fluency achievement?

Method

Oral reading fluency was selected as a measure for this study because it is an indicator of overall reading competence (Fuchs et al., 2001). A prime component of oral reading fluency includes phonological awareness (PA), defined as the ability to segment the flow of speech over time into words, syllables, and phonemes, to blend phonemes, and to manipulate segmented speech sounds (Moritz et al., 2013). The rhythmic interventions for this study were chosen based on rhythmic ability measures used in previous research that compared rhythm skills and PA (Anvari et al., 2002; Atterbury, 1985; Bryant et al., 1989; Douglas & Willatts, 1994; Forgeard et al., 2008; Gordon et al., 2015; Moritz et al., 2013; Overy, 2003). These interventions involve keeping a steady beat, rhythm production, and rhythm discrimination activities. The school's general music teacher administered the interventions for this study.

Participants. The participants included first-grade (n = 34) and second-grade (n = 38) students from a suburban public primary elementary school in the southern part of the United States (male, n = 37; female, n = 35). The total population is approximately 645 students with 47% guardian self-reported as economically disadvantaged and eligible for free and/or reduced lunch. The school’s demographics are 44.4% Caucasian, 25.8% African American, 18.7% Hispanic, 4.0% Asian, and 7.1% other. English Language Learners (ELL) make up 14.2% of the school population. The participants consisted of two classes from each grade level that varied in musical and reading ability and were selected based on students’ course scheduling. This ensured that students chosen for the treatment groups could meet together for the rhythmic intervention.

All participants and their guardians signed consent forms in accordance with university and district institutional review board procedures. Oral reading fluency scores remained anonymous.

Measurement Instrument. All participants participated in a pretest and posttest using the oral reading fluency portion of the Dynamic Indicators of Basic Early Literacy Skills (DIBELS)- 6th edition (University of Oregon Center on Teaching and Learning, 2014). DIBELS are a set of procedures and measures for assessing the acquisition of early literacy skills from kindergarten through sixth grade. These skills include: (a) letter naming fluency, (b) initial sound fluency, (c) phoneme segmentation fluency (all three measured in kindergarten and first-grade), (d) first sound fluency (measured in kindergarten only), (e) nonsense word fluency (measured in kindergarten through second-grade), (f) oral reading fluency, (g) retell fluency (both measured in first- through sixth-grade), and (h) word use fluency (measured in kindergarten through third grade). The other sections of DIBELS were not used as measures in this study due to time constraints and a focus on oral reading fluency.

There is no technical manual available for DIBELS- 6th edition. However, the DIBELS website provides a list of articles, technical reports, book chapters, and dissertations regarding the development and use of DIBELS. Six of these references specifically refer to the oral reading fluency component of DIBELS. Reliability was assessed using alternate-form (.89 - .94) and test-retest (.92 - .97) (Tindal, Martson, & Deno, 1983). Criterion-related validity studied in eight separate studies in the 1980s reported reliability coefficients ranging from .52 to .91 (Good & Jefferson, 1998). The DIBELS purported overall good psychometric properties for evaluating oral reading fluency and was further chosen based upon school access and consistent use of the DIBELS in other areas of the school where this study was conducted. DIBELS provides a ranking system to track student progress while administering each of its measures. For the oral

reading fluency (ORF) words correct assessment, the system includes three categories: intensive (low achieving), strategic (average achieving), and core (high achieving). Each category is assigned a recommended range of correct words read per minute based on grade level and assessment period (beginning, middle, or end of the school year). For the current study, we used rankings in both first- and second-grade for the pretest groupings of achievement level based on the middle of the year assessment period. The ranges for first-grade are as follows: intensive (0-20) strategic (21-33) and core (34 and above). The ranges for second-grade are as follows: intensive (0-72) strategic (73-99) and core (100 and above).

Research Design and Procedure. The researcher who conducted the study was the school's general music teacher. We pretested all participants ($N = 72$) on their oral reading fluency ability using part of an assessment called the Dynamic Indicators of Basic Early Literacy Skills (DIBELS). First- and second-grade students were asked to read aloud a brief passage for one minute. In order to avoid potential practice effects, the available 40 passages were sorted based on any passages that had already been used as a formative assessment or Response to Intervention (RTI) tool in the participants' classrooms. The first- and second-grade passages were then randomly selected (provided in Appendix A for online supplemental use) using Google's random number generator. The first random number produced was used for the first-grade passage (11) and the second number (5) for the second-grade passage. The test was scored in real time by the researcher dichotomously (e.g., right/wrong) for each word in the passage, with considerations toward speed and accuracy.

Participants were matched with peers in their class based on their oral reading fluency pretest scores. After splitting the pairs into three categories based on the DIBELS Oral Reading Fluency Data System Rankings: intensive (low achieving, first-grade $n = 2$ and second-grade $n =$

11), strategic (average achieving, first-grade $n = 6$ and second-grade $n = 7$), and core (high achieving, first-grade $n = 26$ and second-grade $n = 20$), each of the matched pairs were randomly split into control and treatment groups: first-grade ($N = 34$; control, $n = 17$; treatment, $n = 17$), and second-grade ($N = 38$; control, $n = 19$; treatment, $n = 19$) using the random assign function in Microsoft Excel to ensure all ability levels were equally distributed and represented. The average raw DIBELS score for the first-grade pretest control group ($M = 53.94$, $SD = 34.93$) and treatment group ($M = 57.06$, $SD = 35.18$) were fairly similar, indicating the groups were split equally. The average raw DIBELS score for the second-grade pretest control group ($M = 62.90$, $SD = 38.97$) and treatment group ($M = 75.68$, $SD = 29.69$) suggest a slight indication of students with higher reading abilities being assigned to the treatment group. However, this is explained by two treatment students' outlier scores of 120 and 140, skewing the average for the treatment group, with only 7% of all second-grade students scoring over 120. Treatment groups underwent rhythmic interventions instead of one of their three physical education blocks (in a six-day rotation) throughout approximately seven, 45-minute sessions. Their matched control peers attended all of their regularly scheduled physical education classes throughout the study. Throughout the intervention lessons, the control group continued to attend regular general music classes with the treatment group. These rhythmic interventions involved three activities: (a) keeping a steady beat, (b) rhythm production, and (c) rhythm discrimination activities (as discussed below).

Steady beat activity. The steady beat activity used instrumental music selections from Feierabend's "*First Steps in Classical Music: Keeping the Beat!"* to accompany a game in his related music curriculum, "*First Steps in Music for Preschool and Beyond*" called, "*Mystery Beat Keeper*" (Feierabend, 2006). In this game, one student is chosen as the guesser and leaves

the room. Another student is the mystery beat keeper. The job of the mystery beat keeper is to keep a steady beat somewhere on their body (tapping their shoulders, patting their lap, snapping their fingers, etc.) while the class copies the motion to the beat of the music. The teacher starts the song and invites the guesser back in the classroom to observe. Each time there is a phrase change, the mystery beat keeper quickly changes where they are keeping their beat and the class copies. If the mystery beat keeper is having difficulty identifying the phrase changes, the teacher may play an instrument (i.e., finger cymbals or bell) to signify the change in phrases. At the end of the song, the guesser has three attempts to identify who the mystery beat keeper is.

Rhythm production activity. The next activity involved rhythm identification where the students were asked to mold a quarter note, quarter rest, and paired eighth notes using Play-Doh. The first half of the intervention lessons, the students had a visual aid, and the second half of the intervention lessons the students molded the rhythmic values from memory. This activity aided with the following rhythmic production activities. The first rhythmic production activity was a game called "teacher versus class" where the students were asked to read together 15, four-beat rhythm cards comprised of quarter notes, paired eighth notes, and quarter rests. Second-grade cards also included un-paired eighth notes and half notes. If the class read a card correctly with no mistakes, they received one point. If a student made a mistake, the teacher received one point. Game scores improved for both first- and second-grade treatment groups throughout the intervention lessons with both groups, ultimately winning the game (Class – 15 pts Teacher – 0 pts).

The next rhythmic production activity involved students echoing four- and eight-beat rhythmic phrases (ending on a quarter rest to solidify phrasing) on non-pitched percussion instruments. The phrases varied in difficulty and only included quarter notes, eighth notes, and

quarter rests. If the students incorrectly echoed a rhythm, the teacher would play it again, noting the specific beat that was incorrect only if the students still continued to misplay it the third time. The last rhythmic production activity included four-beat rhythmic notation. First-grade students began notating rhythms with different colored felt heart cut-outs that represented quarter notes (large red) quarter rests (large white) and eighth notes (smaller pink hearts). The students begin drawing actual rhythmic notations with wet erase markers for the fourth intervention lesson and every following lesson. Second-grade used wet erase markers for all notation lessons. Each rhythm was played three times with a brief 15-second pause in between to allow the students to process the rhythmic pattern. There was no reward or penalty for correct or incorrect answers. The general music teacher designed both rhythm production activities.

Rhythm discrimination activity. The final activity included rhythmic discrimination. Students received an index card that stated the following: "I have (four beat rhythm). Who has (different four-beat rhythm)?" The students were then asked to practice the notation on their card for two minutes, speaking (e.g., tah for quarter rest and ti-ti for eighth notes) and playing the rhythms with a non-pitched percussion instrument. The first time this game was played, the cards were distributed in order around the circle, so the students knew when it was their turn to play. This allowed the students to listen to each rhythm without fear of playing out of turn. For the remaining lessons, students received the cards at random, which required the students to focus on discriminating if the rhythm they heard was the same or different from the rhythm on their card. Each class was timed to see how quickly they could complete the entire set of cards (with a dull metronome in the background to aid in the accuracy of rhythmic performance). The general music teacher designed this activity.

Second-grade students also had time to do one more activity after the discrimination game on the third intervention lesson and every lesson after that. Students learned an Irish folk dance, from Weikart's Rhythmically Moving series, "*Rakes of Mallow*" (Weikart, 2003) The focus of the dance was demonstrating steady beat and phrasing through movement.

After the treatment interventions, all students in the control and treatment groups for both first- and second-grade were administered a posttest using the same excerpt from the pretest. All testing procedures described for the pretest were followed in the posttest.

General Music Curriculum. The general music teacher who conducted this study is certified in Level 2 of the Orff Schulwerk method as well as Feierabend's "First Steps in Music" training (Feierabend, 2006). The general music curriculum used at the school in this study draws from the Orff pedagogy as well as lessons provided by the GAMEPLAN curriculum written by Kriske, DeLelles and Feierabend's "First Steps in Music" curriculum (Kriske & DeLelles, 2005; Feierabend, 2006). Both curricula and their supplemental materials were provided as research-based quality resources to all general music classrooms in the county in which the study took place. Although the music standards of the representative state were addressed at some point throughout the year in the general music class, first- and second-grade curricula were tailored toward one pitch and one rhythmic concept that reflected the quarterly assessment required by the representative county in which the school resides. At the time in which this study took place, first-graders focus was accurately performing call and response songs and consistently reading quarter and paired eighth notes and quarter rests using non-traditional and/or traditional notation. Second-graders focus was consistently reading simple two or three note melodic patterns within a treble clef staff and improvising simple rhythmic patterns using a variety of sound sources.

Psychometric Considerations. The Rasch measurement model was used to transform the observed, raw student scores gleaned from the DIBELS into linear measures and as a method to investigate the construct and predictive validity of the measure. Researchers often prefer Rasch measurement theory (Rasch, 1960/1980) when investigating the psychometric properties (i.e., validity and reliability) of a measure in the behavioral, social, and health sciences (Engelhard, 2013). In the case of this study, student responses (e.g., dichotomously scored as right/wrong answers) were modeled as a logistic function of student ability and item difficulty parameters. In particular, the benefit of the Rasch measurement model its properties of invariant measurement (Engelhard & Perkins, 2011): (a) item-invariant measurement of persons (i.e., the measurement of persons must be independent of the particular items that happen to be used for the measurement); (b) non-crossing person response functions (i.e., a more able person must always have a better chance of success on an item than a less able person; (c) person-invariant calibration of test items (i.e., the calibration of the items must be independent of the particular persons used for calibration); (d) non-crossing item response functions (i.e., any person must have a better chance of success on an easy item than on a more difficult item); and (e) variable map (i.e., items and person must be simultaneously located on a single underlying latent variable). The properties of the model allow for the simultaneous estimation of student scores and item difficulties in a way that does not affect the expectations of the model (i.e., sample-independent measurement). Model data fit provides a quality indicator as to the predictability of responses based upon expectations of the measurement model. When adequate fit to the model is observed, invariant measurement is achieved, allowing for confidence in the estimated measures as well as any inferences made from them.

Results

Summary Statistics. Table 1 provides the summary statistics for first-grade, and Table 2 provides those for second-grade students. The summary statistics table includes two facets that were included in the measurement model: (a) students (representing students' achievement based upon assignment into control and treatment groups), and (b) items (representing item difficulty). Each facet was analyzed and recorded in the table for both first- and second-grade.

Results for first-grade students indicated statistically significant differences for student achievement ($X^2 = 5342.40$, $p < .01$, $Rel = .99$). For student achievement (i.e., the objects of measurement), reliability of separation can be interpreted similarly to Cronbach's alpha, in that the students could be reliably separated based upon their achievement level with high reproducibility. High reliability of separation for the item facets (i.e., the agents of measurement) implies that there is enough separation to measure student achievement through the range of achievement levels ($X^2 = 5852.50$, $p < .01$, $Rel = .98$). Infit and outfit statistics provide information on the quality of the patterns of responses, or more specifically, the size of the random predictability within the model. Good data fit to the model is evidenced by mean square infit values close to the expected value of 1.00. For a study conducted in an authentic classroom, acceptable range for productive parameter-level MSQ is between 0.50 and 1.50 (Wright and Linacre, 1994). Overall, significant chi square statistics, high reliability of separation, and good model data fit indicate strong construct validity (item facet performance) and predictive validity (student facet performance) for each measure.

Results for second-grade students indicated statistically significant differences for second-grade achievement ($X^2 = 5307.40$, $p < .01$, $Rel > .99$). Both the infit and outfit statistics for all facets in the model fall within the range of 0.50 to 1.50, indicating overall good model fit.

High reliability of separation for the item facets implies that there is enough separation to measure student achievement through the range of achievement levels ($X^2 = 6253.30$, $p < .01$, *Rel* = .98). Similar to the first-grade measure, significant chi square statistics, high reliability of separation, and good model data fit indicate strong construct and predictive validity evidence.

Variable Maps. The variable maps provided in Figure 1 are graphical representations of the construct investigated in this study. There are three columns represented. The first column shows the logit scale. The logit scale is conceived of as a hypothetical ruler marked in equal logit units. The second column provides the achievement measure for where each student falls on the logit scale from low achieving (bottom) to high achieving (top). For visual clarity purposes, there is an asterisk to indicate each student. The third column provides the item difficulty measures in terms of difficulty. Each word in the reading passage represents an item, with easier items at the bottom of the column and more difficult items at the top of the column.

Calibration of Students and Items. Individual student and item calibration data can be found online in Appendices A, B, C, and D. The student pre- and posttest data were run as one analysis for both first- and second-grade. Student numbers 35-68 for first-grade and 39-76 for second-grade indicate posttest scores. For the first-grade pretest, student 12 (control group) was the highest achieving reader (3.37 logits), and student 34 (control group) was the lowest achieving reader (-7.86 logits). For the second-grade pretest, student 23 (control group) was the highest achieving reader (4.84 logits), and student 31 (control group) was the lowest achieving reader (-6.76 logits). For the first-grade posttest, student 66 (control group) was the highest achieving reader (7.01 logits), and student 68 (control group) was still the lowest achieving reader (-7.23 logits). For the second-grade posttest, student 44 (treatment group) was the highest

achieving reader (8.90 logits), and student 57 (control group) was the lowest achieving reader (-5.31 logits).

Evidence of misfitting students is based on infit and outfit *MSE* statistics outside of the rule-of-thumb ranges of 0.40 and 1.60 logits for an authentic classroom-type study as indicated by Wright and Linacre (1994) and Engelhard (2013). Misfit students (and items, similarly, in later discussion) indicate that the responses were either too sporadic or too predictable in relation to the expectations of the model. Students with fit indices above the recommended range of 1.60 indicate responses too sporadic for productive for measurement based upon the expectations of the model. Students with fit indices below the recommended range of 0.40 indicate responses too predictable for productive measurement based upon the expectations of the model.

Four first-grade students exhibited misfit for their infit pretest scores and all but two first-grade students exhibited misfit for their outfit pretest scores, with a majority being underfit. Only two first-grade students were within the acceptable range for both infit and outfit scores on their pretest. Six first-grade students exhibited misfit for their infit posttest scores and twenty-four first-grade students exhibited misfit for their outfit posttest scores. However, ten first-grade students were within the acceptable range for both infit and outfit scores on their post-test.

Similarly, four second-grade students exhibited misfit for their infit pretest scores, and all but eleven students exhibited misfit for their outfit pretest scores. Those eleven students were all within the acceptable range for both infit and outfit scores on their pretest. Eight second-grade students exhibited misfit for their infit posttest scores, and all but ten second-grade students exhibited misfit for their outfit posttest scores. Those ten students were all within the acceptable range for both infit and outfit scores on their post-test.

Seven first-grade items exhibited an overfit for infit, and all but twenty items exhibited misfit for outfit. The following first-grade items (words) all first-grade students read correctly on the pretest: 1 (it), 6 (I), and 12 (the), the first time they appeared in the passage. The following first-grade items all students read correctly on the posttest: 11 (in), 12 (the), 16 (tired). Although "it" and "I" were no longer included, they were only missed by a handful of students on the post-test. It is likely that "tired" was added to this list because it appeared as item 8 before it appeared again as item 16, resulting in a practice effect. The most difficult item on the first-grade pretest was item 137 (all), and posttest was item 136 (and). However, these items are most likely not hard to read, but rather words most students did not reach given the time restraints to read the passage.

Nineteen second-grade items exhibited misfit for infit and all but twenty-four items exhibited misfit for outfit. The following second-grade items all students read correctly on the pretest: 1 (I), 4 (the), 6 (is), and 13 (or). The following second-grade items all students read correctly on the posttest: 1 (I), 3 (that), 8 (for), 11 (flying), 21 (the), and 22 (wind). Again, item 4 (the), 6 (is), and 13 (or) were only missed by a handful of students on the post-test. It is also likely that item 22 (wind) was a result of practice effect from item 5 (wind) and 16 (wind). The most challenging item on the second-grade pretest was item 142 (can), and posttest was item 134 (blows). Again, these items are most likely not hard to read, but rather a word most students did not reach given the time restraints to read the passage.

The total items used to determine the measure of students' achievement were based on the highest achieving student in both first- and second-grade, respectively. In other words, items (i.e., words) that went beyond the final word read at the end of the one-minute mark of the highest achieving reader in both grades were removed from the analysis to focus on qualitative

information about how students were behaving. While the knowledge of misfit items is not pertinent to the current study, it can be beneficial diagnostic information to the classroom teacher (e.g., what specific words are causing problems that might have an effect on oral reading fluency). This qualitative information is similar to a formative assessment, rather than a summative assessment on overall oral reading fluency ability and can be used to tailor further reading instruction.

Analyses of Covariance (ANCOVA). The second research question for this study was to determine the effect of rhythmic interventions on first- and second-graders' oral reading fluency scores. Table 2 shows means and standard deviations for each grade (first/second), posttest rank, and group (control/treatment). After controlling for differences in pre-test scores, univariate between-subjects Analyses of Covariance (ANCOVA) were conducted for each grade level, with group (control/treatment) as the independent variable, and oral reading fluency posttest scores as the dependent variable, and the corresponding pretest and rankings as covariates. Table 3 shows the results. For first-grade, there was a significant difference for the treatment group when compared to the control group ($F(1, 33) = 8.90$, $p < 01$). Students in the treatment group reported significantly higher oral reading fluency scores after participating in the rhythmic intervention ($M = 2.10$, $SD = .70$) ($p < .01$).

The third research question was to identify the interaction effect between rhythmic interventions and fluency achievement. Table 4 provides results. For first-grade, there were no statistically significant interaction effects. For second-grade, a significant interaction effect was found between in means scores of the treatment group ($F(2, 36) = 3.472$, $p = .044$) for the core grouping ($M = 2.30$, $SD = .39$). Students in the treatment group with higher pretest scores tended to have higher gain scores in oral reading fluency after rhythmic interventions. In other words,

the rhythmic intervention was especially effective at improving oral reading fluency scores for second-grade students who began with higher literacy skills.

Conclusion

The purpose of this study was to explore the effect of rhythmic interventions (i.e., steady beat, rhythm production, and rhythm discrimination activities) on oral reading fluency scores of first- and second-grade music students. The first research investigated the psychometric quality of the Dynamic Indicators of Basic Early Literacy Skills (DIBELS) used in the context of measuring the oral reading fluency of first- and second-grade general music students. The results indicate that DIBELS provided strong construct validity and predictive validity evidence. Students were able to be reliably separated based upon oral reading fluency ability, with the majority of items properly targeting the achievement level of the student sample, consisting of mostly medium difficult items and less items being overly hard or overly easy.

The second research question investigated the effect of rhythmic interventions on first- and second-graders' oral reading fluency scores. The results indicate that the rhythmic interventions were successful at improving oral reading fluency scores for both first- and second-grade students. In first-grade, only one student in the treatment group, student 25, decreased in score by 1.24 logits, while the rest of the treatment group increased by an average of 1.64 logits. Student 25's decrease in score represents reading 9 less words towards the end of the one minute mark from pretest to posttest, which would indicate a decrease in speed of reading rather than a decrease in the ability to read the words correctly. The first-grade control group scores increased by an average of 1.42 logits, with two students decreasing in score: student 16 by .14 logits and student 17 by .88 logits. Although student 16 increased in number of words read (79 to 82) the student misread words on the posttest that he/she originally read correctly on the pretest,

explaining the decrease in score. Student 17's decrease in score is a result of a decrease in speed of reading, and not words read incorrectly. In second-grade, the treatment group increased by an average of 1.25 logits, with four students (student 47, 50, 51, and 53) decreasing in score (.5 logits, .98 logits, 1.32 logits, and .63 logits) respectively. Because student 47 unintentionally skipped a line of text when reading on the pretest, the researcher made a point to remind them not to skip lines when administering the posttest. All students received this reminder before the posttest that skipped lines of text on the pretest. However, the reminder could have possibly caused the student to read more attentively, explaining the decrease in score from 120 to 118 words read correct on the posttest. Student 50 increased his/her words read correct from 140 to 162, which might indicate that the intervention is more effective, or results in greater growth for low-achieving readers rather than high-achieving readers. Student 51 read ten less words and student 53 read five less words correctly at the one minute mark on the posttest, indicating a decrease in speed of reading rather than a decrease in the ability to read the words correctly. The second-grade control group increased by an average of 1.33 logits, with three students (student 39, 40, and 55) decreasing in score (.15 logits, .37 logits, and .25 logits) respectively. Each of these students read three or fewer less words correctly at the one minute mark on the posttest, again, indicating a decrease in speed of reading rather than a decrease in the ability to read the words correctly.

While it may appear that the significant increase between first- and second-grade growth can be attributed to the reading skills that are acquired over time, it is important to consider that the passages in which these students were tested were written specifically for the assumed abilities of the students in that age range. It stands to reason then that another plausible explanation of large growth in second-grade is due to the fact that those students were exposed to

an extra school year of general music class, leaving one to conclude that their rhythmic abilities were far more developed than the first-grade students.

Discussion

For this study, we compared first- and second-graders oral reading fluency (ORF) scores on a pre- and post-test using DIBELS ORF assessments. Each grade was matched with their classroom peers based on pre-test scores and then randomly split into control and treatment groups. Treatment groups were provided rhythmic intensive music lessons at the same time that their matched control group peers attended their regularly scheduled physical education classes. Both control and treatment groups attended their regularly scheduled general music classes throughout the study.

Table 5 provides descriptive statistics for the raw pre- and post-test ORF scores for first- and second-grade treatment and control groups. These raw scores indicate that the first-grade treatment group improved by 19.41 words read correctly in one minute compared to those in the control group that read 13.95 words correct in one minute. Second-grade had similar results, with the treatment group improving by 16.74 more words versus 11.52 words in the control group. For both grades, the treatment group read approximately five more words correctly than their matched peers in the control group on the post-test.

When looking at DIEBELS ORF system rankings (intensive, strategic, and core) for each grade level, results indicate that the students in the first-grade control group that started in the strategic ranking reading 13-18 words in one minute (n = 4) dropped to the intensive ranking reading 0-30 words in one minute on the post-test. The same students that started in the core ranking (n = 12) reading 19 words and above stayed in the core ranking reading 47 words and above on the post-test. The first-grade treatment group had one student drop out of the core

ranking (n = 14) to strategic on the post-test but had fewer students drop down to the intensive ranking from strategic (n = 2) than their matched peer control group.

For second-grade, results indicate that students in the control group mainly stayed in their same ranking classifications for pre- and post-tests, while four students in the treatment group that ranked as core on the pre-test (n = 11), reading 76 words and above in one minute, dropped down to the strategic ranking, reading 75-95 words in one minute on the post-test. However, two students moved up from intensive to strategic and strategic to the core, respectively. For both grades, these results indicate that the rhythmic intervention may be more effective for low-achieving readers.

With the implementation and effects of Race to the Top, many states across the country have prioritized reading fluency in many elementary school-wide initiatives taught in all subject areas, including music (Sanchez & Turner 2017). Integrating reading into a general music curriculum can be troublesome when students are expected to consistently demonstrate an understanding of over 25 music standards in a year, which for most elementary music teachers consists of a maximum of 30, 45-minute classes.

It is well known that if children cannot read proficiently by the end of third grade, they face many hurdles to success in school and beyond. In 2015, the Center for Public Education published a staggering statistic, more impoverished children hear as few as three million words in their first three years of life compared to eleven million words for children in wealthier families (Zakariya, 2015). Since the foundation for reading lies in the oral language children are exposed to and develop in the first three years of life, many elementary schools face a daunting task to provide effective interventions that will result in all children reading at grade-level.

The Center for Public Education (CPE) proposes a series of steps that can help schools serving low-income and/or minority children. Through Title I funding provides access to high-quality pre-K programs that will improve children's school readiness. The CPE also recommends providing more individual time in and after school, such as free tutoring programs. Strong community partnerships and effective family outreach are other components to getting parents on board to support their children's reading habits. Equally important is professional development, which is becoming more and more difficult with district cutbacks. The results of this study suggest that rhythmic interventions can be a cost-effective instructional reading strategy for classroom teachers to utilize when school districts have access to the expertise of highly qualified general music educators. Also, music lessons do not seem to carry the same stigma as going to a reading specialist, which may make receiving additional support more appealing to students (Fernandez & Hynes, 2016).

Implications and Future Research

While results indicated an overall statistically significant treatment effect for first-grade students and a statistically significant interaction effect for the core grouping of second-grade students, the effect size was rather small due to a small sample size. Although the treatment was beneficial to improving oral reading fluency scores over a short time period, a longer intervention period and a larger sample size is needed to understand the effects of treatment better. A longitudinal study across grade levels would be even more beneficial. Future studies could also compare the effects of targeted rhythmic training against additional reading instruction of matched peers. It would also be beneficial to administer a pre- and post-rhythmic abilities assessment to provide further insight into the effect of a rhythmic intervention on oral reading fluency.

Additionally, more literacy assessments should be incorporated to compare against the impact of rhythmic interventions. Two possible assessments are the Scholastic Reading Inventory (SRI) and the Fountas and Pinnell (F & P) Benchmark Assessment, both of which many school districts across the United States utilize as common reading assessment tools. The SRI, (Scholastic Inc., 2014) is a reading comprehension test that focuses on the skills readers use when studying written materials from various content areas. These skills include identifying details in a passage, identifying cause-and-effect relationships and the sequence of events, drawing conclusions, and making comparisons and generalizations. The F & P Benchmark Assessment (Heinemann, 2018) is a formative assessment designed to monitor students three times throughout the school year. The assessment determines accuracy, fluency, and comprehension for each grade level. The F & P system also provides an extensive collection of graded reading books at the appropriate level of challenge for students using a Text Level Gradient that ranks texts by alphabet for each grade (e.g., A-D is for kindergarten, E-J is for first-grade, K-M is for second-grade, etc.). Multiple reading assessments would provide a broader picture of the growth of struggling readers after a period of rhythmic interventions.

The results of this study have implications not only for students but for teachers as well. Several states have implemented new legislation regarding teacher evaluations in recent years. In 2016-2017 the Teacher Keys Effectiveness System (TKES) was implemented in Georgia as a common evaluation system including three components: Teacher Assessment on Performance Standards (TAPS), Professional Growth, and Student Growth (Georgia Department of Education, 2017-2018). The TAPS component includes the typical teacher evaluation and observations and makes up 50% of the total effectiveness rating. Each teacher determines the professional growth measure based on needed professional development and makes up 20% of

the total effectiveness rating. Also, the student growth measure (30%) is based on state assessment data for Student Growth Percentiles (SGP). Non-SGP teachers (e.g., music educators) are also required to have a student growth measure, which for most Georgia counties deliver in the form of a district developed assessment, the Student Learning Objective (SLO). For early elementary classroom teachers, the SRI is one type of assessment recognized by the state as a measurement of student growth. With so much at risk for educators – promotion, compensation, and retention – classroom teachers and principals should consider the impact that 45 minutes of rhythmic activities per week, less than 3% of teacher/student contact time, can have on improving reading scores, mainly with struggling readers. Moreover, music teachers can equally benefit by providing extra practice to improve student's music SLO scores.

While one study cannot provide enough evidence to support the claim that music instruction focused on rhythmic training will improve oral reading fluency scores, this study provides another link to the existing literature suggesting that rhythmic and reading ability are strongly correlated.

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Table 1

Summary Statistics for 1st and 2nd Grade from the PC-MFR Model

	1st Students	1st Items	2nd Students	2nd Items
Measure (Logits)				
Mean	-0.84	-0.07	0.40	-0.06
SD	3.46	3.75	3.31	3.70
N	68	146	76	142
Infit *MSE*				
Mean	0.80	0.84	0.84	.89
SD	0.69	0.37	0.72	.43
Std. Infit *MSE*				
Mean	-1.80	-0.80	-1.40	-0.70
SD	3.0	1.50	2.90	1.70
Outfit *MSE*				
Mean	1.77	2.26	2.15	2.51
SD	3.09	3.33	3.30	3.43
Std. Outfit *MSE*				
Mean	1.10	1.80	1.00	1.50
SD	1.70	1.40	1.60	1.10
Separation Statistics				
Reliability of Separation	0.99	0.98	0.99	0.98
Chi-Square	5342.40*	5852.50*	5307.40*	6253.30*
Degrees of Freedom	67	145	75	141

* $p < 0.01$

Table 2

Descriptive statistics for DIBELS Oral Reading Fluency Rankings on First- and Second-Grade Posttest

	N	Mean (Logits)	SD (logits)
1st Intensive			
Control	1	-7.23	-
Treatment	1	-4.84	-
1st Strategic			
Control	4	-4.55	0.35
Treatment	2	-2.94	2.43
1st Core			
Control	12	1.45	2.21
Treatment	14	3.01	1.84
2nd Intensive			
Control	7	-3.31	1.67
Treatment	4	-1.28	1.57
2nd Strategic			
Control	3	1.08	0.78
Treatment	4	1.23	0.91
2nd Core			
Control	9	2.93	1.25
Treatment	11	3.67	2.77

Note. First-Grade Rankings: Intensive (0-36 words), Strategic (37-68 words), and Core (69 words and above). Second-Grade Rankings: Intensive (0-83 words), Strategic (84-110 words), and Core (111 words and above).

Table 3

Analyses of Covariance for First- and Second-Grade DIBELS Oral Reading Fluency Assessment

	MS	*F*	$\eta 2$
1st Grade			
Ranking	3.22	2.12	.13
Treatment	13.60	8.90*	.25
Ranking*Treatment	1.27	.83	.06
2nd Grade			
Ranking	.12	.09	.01
Treatment	4.61	3.49	.10
Ranking*Treatment	4.59	3.47*	.18

*$p < .05$

Table 4

Pairwise Comparisons

	M	*SD*
1st Grade		
Treatment	2.10*	.702
2nd Grade Treatment		
Intensive	1.22*	.66
Strategic	1.25*	.58
Core	2.30*	.39

*$p < .05$