Effectiveness of Gamification for Enhancing Rhythm-Reading Skills

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Abstract

This study examines whether a rhythm-based video game can enhance rhythm-reading skills as effectively as traditional worksheet practice. We recruited undergraduate music students, randomly assigned them to either a worksheet condition or a video game condition, and measured their rhythm-reading performance on pre- and post-tests. Although overall results showed no statistically significant improvement in either group, students in both conditions reported moderate to high levels of engagement. These findings underscore the need for additional research on implementing gamified tools in music education, particularly when teaching core skills such as rhythm reading.

1 Introduction

Rhythm literacy is a core skill in music education, yet traditional strategies such as clapping exercises and repetitive drills often struggle to maintain student engagement [9]. Researchers have increasingly turned to digital tools and game-based learning to address this motivational gap [11]. In particular, rhythm-based video games provide interactive features like immediate feedback, engaging challenges, and dynamic levels of difficulty. These elements could encourage students to practice more consistently and to enjoy developing their rhythm-reading skills.

To investigate whether a custom rhythm-based game meaningfully boosts students' rhythm-reading proficiency, we conducted a between-subjects experiment with undergraduate music students. Participants were randomly assigned to either a game or worksheet condition, completed a rhythm-reading pre-test, spent 30 minutes in their assigned practice activity, and then completed a post-test. Results showed no statistically significant improvement in either condition, although both groups reported moderate to high levels of engagement. These findings suggest that while a single 30-minute session may not produce measurable gains, gamified approaches may still hold promise as a motivational tool and warrant further study with more extensive practice.

2 Related work

2.1 Rhythm Education

Rhythm literacy is a crucial learning objective within music education that is taught early. Music students are expected to recognize and play standard rhythmic patterns; for example, U.S. national standards by sixth grade include reading and identifying standard rhythm notation [6]. Training in rhythm reading typically involves repetitive practice, such as clapping exercises, vocal counting. Methods like the Kodály approach [10, 7] often serve as foundational tools by incorporating voice, simple syllables, and folk songs to help students internalize beat, meter, and pitch relationships. Although these methods are effective, many students lose engagement over time. Research in music education has noted that lack of interest and motivation often hinders progress in music notation reading [9]. To sustain engagement and ensure learners build a strong rhythmic foundation, educators have turned to interactive strategies, including software-based drills and small-group improvisation exercises, with varying degrees of success.

2.2 Video Games for Increasing Musical Aptitude

In recent years, educators increasingly rely on digital games to revitalize music learning [9]. Gamification leverages features like point scoring, instant feedback, levels, and narrative storylines to motivate learners. In music education specifically, using game elements has been linked to greater student participation and enjoyment in class [3]. Several studies have explored how interactive rhythm games improve practice time and engagement [4]. For example, interactive rhythm-based video games have been found to increase students' willingness to practice independently, as they provide immediate feedback and entertaining challenges [1]. While these studies show promise, many lack rigorous controls (e.g., no randomized assignment or no valid comparison group), have relatively short intervention times, or use teacher-led instruction along with the game, making it difficult to isolate the effect of the game [6]. Additional controlled research directly comparing gamified learning with standard methods is therefore needed to validate its effectiveness.

2.3 Video games for increasing rhythm reading ability

Many commercial rhythm-action games (e.g., *Guitar Hero*, *Rock Band*) have been studied for their potential effect on musical skill acquisition. Some findings suggest that these games requiring players to perform actions in time with visual cues can enhance basic timing skills [5]. For instance, Peppler et al. observed that students in an afterschool *Rock Band* program developed better beat coordination over a period of months. However, other research indicates indicates these timing benefits may not always transfer to traditional music-reading tasks [8, 2]. Still, a key consistent finding is that students self-report high enjoyment while playing, which can indirectly boost their overall practice time [4, 3].

Most prior studies measured general musical aptitude (e.g., pitch recognition) rather than isolating rhythm reading. Moreover, the majority of these commercial games rely on scrolling, abstract symbols rather than presenting standard Western musical notation. This limits the assessment of skills that are directly transferable to traditional music reading. In contrast, our study focuses on rhythm reading using Western notation—displaying rhythms on a standard staff with conventional note values. Although a few educational games, such as *Rhythm Cat*, use this notation and have shown promise in enhancing rhythm reading [6], they have not been as rigorously tested as commercial rhythm games. By comparing our gamified approach (which employs authentic Western musical notation) to a worksheet-based practice condition, we aim to fill this gap and directly assess the effect of training with conventional notation on rhythm reading.

3 System Design

To address the challenges outlined above—such as limited engagement, lack of immediate feedback, and insufficient supplementary practice—we developed a rhythm-based video game featuring a short narrative and real-time note accuracy indicators. Below, we describe the key gameplay loop and how it aims to maintain engagement while reinforcing rhythm reading with Western musical notation.

3.1 Gameplay Loop and Design

Our rhythm game is set in a space-themed environment and integrates the following core components:

1. **User Authentication and Entry:** Players begin by accessing the game via a secure online portal after providing consent and receiving a personal ID.

2. **Brief Narrative Setup:** Players are shown a quick cutscene of a planet being targeted by an asteroid. The short story context sets a playful tone to enhance engagement and immersion.

3. **Instruction and Onboarding:** A brief instructional segment familiarizes players with the game mechanics. Standard rhythm notation (e.g., quarter notes, eighth notes) is displayed on-screen in measures. A musical piece plays audio in time with the beat so players can gauge tempo.[**Figure 1 shows a screenshot of the gameplay interface.**]

4. **Active Gameplay:** In a space-themed environment, players navigate through levels by pressing the space bar to dodge asteroids. Although only one key (the spacebar) is used, every note on the staff has

a corresponding "hit window." Players must press the spacebar precisely when each note aligns with the metronome beat. The level difficulty increases gradually to offer an appropriate challenge.

5. **Instant Feedback:** Each note press is highlighted on the screen as soon as the spacebar is pressed:

   - A green note appears if the timing is accurate.
   - A red circle indicates the note was played too early or too late.
   - A yellow circle indicates the note was played close.

   A dynamic multiplier increases with every consecutive accurate press and resets to 1.0 after a mistake, contributing to a numerical score displayed in real time. This real-time display offers players instant guidance on how well they are tracking the beat. [**Figure 2 shows a screenshot of the instant feedback during gameplay.**]

6. **Rewards and Progression:** At the end of each sequence, players receive a summary of how many notes were hit accurately. A star rating (one to three stars) is shown along with a number score, and the next level features slightly more complex or faster rhythms. Players can retry any level multiple times without penalty.[**Figure 3 shows a screenshot of the feedback interface.**]

By presenting standard rhythmic notation in an interactive, story-driven environment, the game aims to combine the motivational elements of gamification with the practical benefits of reading Western music notation.

3.2 Screenshots

Figure 1: Gameplay Screen showing rhythmic cues and the metronome.

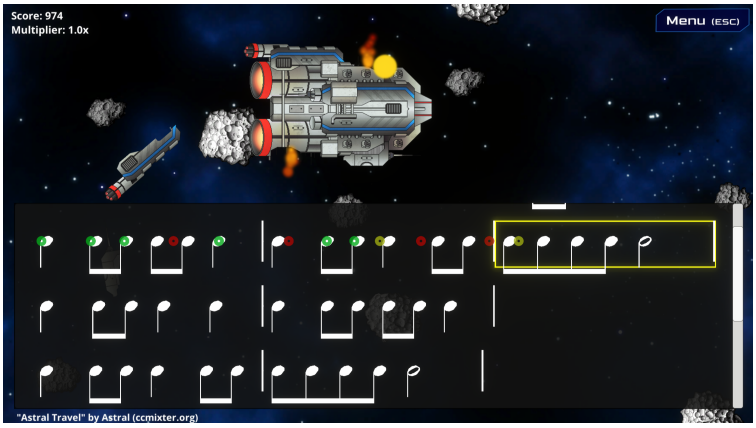

Figure 2: Instant feedback during the game displaying note accuracy with green/yellow/red markers.

Figure 3: Ending feedback screen displaying the star rating and score.

3.3 Rhythms Used in the Game and Worksheet

The rhythms on the worksheet and the game were the same.

They were designed as a natural progression:

- Quarter notes
- Half notes
- Whole notes
- Ties
- Simple eighth note and eighth note + quarter note patterns
- Dotted quarter note followed by eighth note patterns
- Eighth-quarter-eighth syncopated note patterns
- Eighth note followed by dotted quarter note patterns
- Basic sixteenth note patterns

4 Testing and Methodology

To evaluate the effectiveness of the rhythm game, we conducted a between-subjects study. Participants were randomly assigned to either a rhythm game or worksheet condition and completed three phases: a pre-test to assess baseline rhythm-reading ability, a 30-minute intervention using either the game or worksheet, and a post-test to measure improvement. User interactions such as keystrokes and timing data were recorded and analyzed using a custom evaluation tool. Our study was approved by Cal Poly's Institutional Review Board.

4.1 Recruitment and Participation

We made short in-class announcements within music-related classes at Cal Poly (e.g., music theory, musicianship, and music appreciation). Within the music department buildings, research study flyers were also posted on bulletin boards. We targeted individuals with some prior musical background to ensure familiarity with basic rhythmic notation.

4.2 Study Design and Data Collection

The online study consisted of four phases: a rhythmic notation pretest, an intervention in the form of a game or worksheet, a post-test, and a survey.

4.2.1 Pretest

After participants signed an electronic consent form, we emailed them login credentials to our research portal. They first completed a rhythm-reading **pre-test**, which asked them to sight-read eight rhythms of progressively increasing difficulty. Participants "performed" these rhythms by pressing their keyboard spacebar in time with a metronome. The system recorded timestamps for each spacebar press.

4.2.2 Intervention

Participants were randomly assigned to one of the two conditions:

1. **Rhythm Game Condition:** Participants played our custom video game for 30 minutes.
2. **Worksheet Condition:** Include somewhere that the rhythms in the worksheet were identical. Participants received worksheet of PDF of rhythmic exercises to practice. They were encouraged to clap, vocalize, or otherwise practice the rhythms however they preferred, just as they might do with traditional music worksheets and homework. After 30 minutes, the worksheet was disabled and participants were brought back to the main portal home screen.

4.2.3 Post-Test and Survey

Following the assigned intervention, all participants completed a **post-test** identical in structure to the pretest. After that post-test, an online Qualtrics survey collected:

- **Self-reported musical background:**
  - How many years of formal musical training have you had?
    Response options: *None, Less than 1 year, 1-3 years, 4-6 years, 7-10 years, More than 10 years*
  - Do you currently play any musical instruments? If yes, which one(s)?
    Response options: *Open text field*
  - How often do you engage with music (e.g., playing, practicing, listening critically)?
    Response options: *Daily, A few times a week, Weekly, A few times a month, Rarely, Never*
- **Subjective impressions of either the game or worksheet:**

  - How engaging did you find the activity?
    Response options: *Likert scale (1 - Not at all engaging to 5 - Very engaging)*
  - How difficult was the task?
    Response options: *Likert scale (1 - Very easy to 5 - Very difficult)*
  - What aspects of the game/worksheet did you find most helpful? Least helpful?
    Response options: *Open text field*

- **Basic demographic information:**
  - In what year were you born?
    Response options: *Open numeric field*
  - What gender do you identify as?
    Response options: *Male, Female, Non-binary, Prefer not to say, Other (with text field)*
  - What race(s) do you identify as? Check all that apply.
    Response options: *White, Black or African American, Hispanic or Latino, Asian, Native American or Alaska Native, Native Hawaiian or Pacific Islander, Other (with text field)*

4.3 Outcomes and Measures

Our primary outcome measure focused on the improvement in rhythm-reading abilities which was determined by comparing pre-test and post-test scores. For each test, we developed a custom evaluation program that replayed the recorded space-bar timestamps alongside audio and tempo count. This tool enabled a measure-by-measure analysis of each performance.

4.3.1 Scoring Criteria

To ensure consistency in our scoring, we aligned our assessment with the *Watkins Performance Scale*, which provided a standard framework for selecting and grading rhythmic passages used in both tests. We applied the following rules:

- **Measure-Based Error Count:** The test was divided into measures, with each measure graded separately. If a participant made one or more mistakes within a single measure, we counted one error for that measure. Additionally, if a participant restarted within a measure, we still counted one error for that measure, even if their restarted attempt was correct.
- **Tempo Deviation:** If a participant deviated from the prescribed tempo, we counted one error for every occurrence of the deviation throughout the test. This was assessed by checking inconsistencies in note spacing relative to the metronome count.
- **Restarting the Test:** If a participant restarted their test from the very beginning, we discarded their previous attempt and counted one error. Grading then began anew from their restarted attempt.

We then totaled the error counts. Thus, a significantly lower post-test error count compared to the pretest indicates a greater improvement in rhythm-reading accuracy.

4.4 Participant Demographics

A total of 27 students completed the study. These students had varied levels of musical experience, ranging from beginners with limited formal training to more advanced students with several years of music education. All students received a $20 Amazon gift card upon completion of the study.

5 Results and Discussion

We conducted a paired-sample t-test to compare the pre-test and post-test scores. The analysis produced a t-statistic of -0.55 and a p-value of 0.59. Because the p-value greatly exceeded 0.05, we found no statistically significant difference between the pre-test and post-test scores.

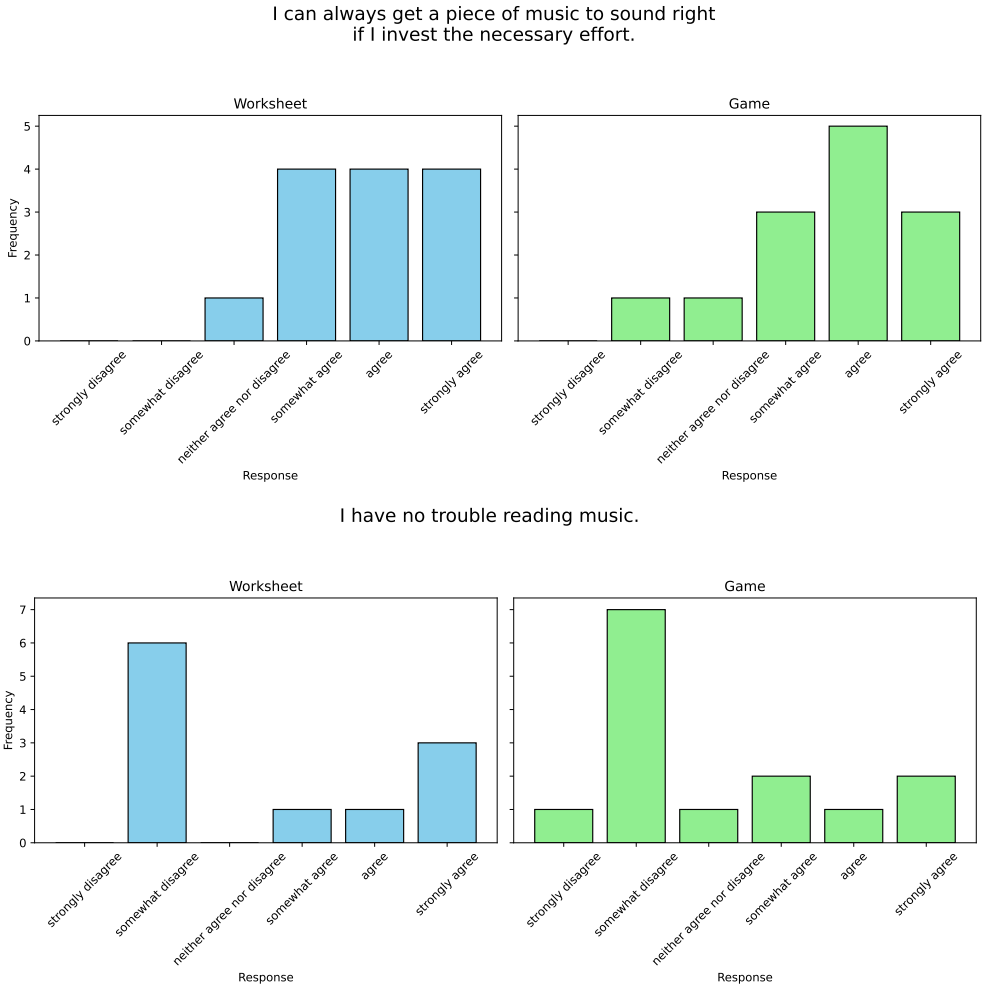

Figure 4: Distribution of music experience amongst students

Statistic	Value
T-statistic	-0.55
P-value	0.59

Table 1: Results of the paired-sample t-test comparing pre-test and post-test scores.

5.1 Improvement Scores

To further understand the data, improvement scores were analyzed separately for the two experimental conditions. Figure 5 shows histograms of the improvement scores for each group, and summary statistics are provided below:

Statistic	**Worksheet Group**	**Game Group**
Count	12	13
Mean	5.0	3.62
Median	3.5	4.0
Standard Deviation	5.39	7.12

Table 2: Summary statistics of improvement scores for Worksheet and Game groups.

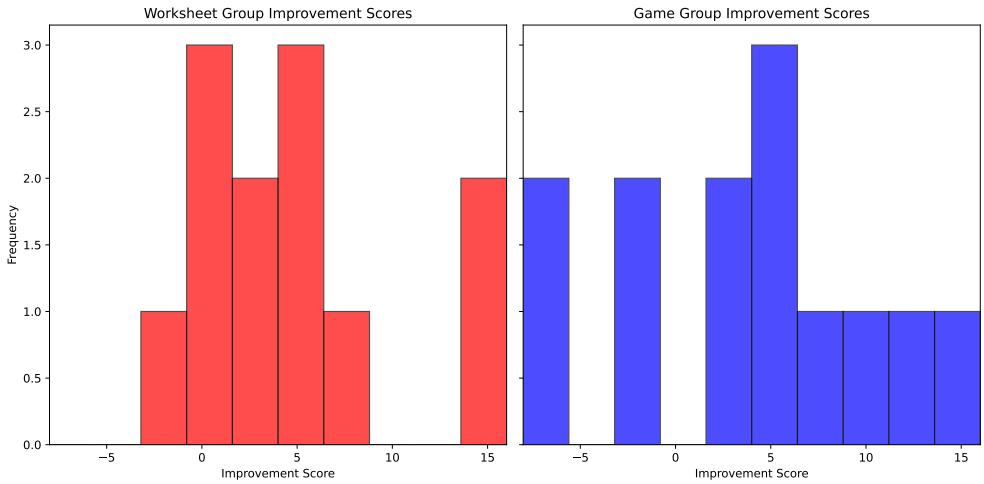

Figure 5: Distribution of improvement scores

Although the Worksheet group shows a slightly higher mean improvement score, the medians are very similar, and the Game group exhibits greater variability. This variability suggests that while some students in the Game condition improved considerably, others did not, leading to a wider spread of scores.

5.2 Implications for Music Teaching and Game Design

We found no statistically significant improvement in rhythm-reading performance, suggesting that neither the game-based nor worksheet-based intervention consistently enhanced learning outcomes.

For music teachers, this highlights the need to assess the effectiveness of digital games or traditional methods in skill development, considering factors like prior experience and engagement. Satisfaction ratings showed that while most worksheet participants were moderately satisfied (9 somewhat satisfied, 2 neutral, 2 somewhat dissatisfied), responses to the game were more polarized, with 4 extremely satisfied, 5 somewhat satisfied, but also 4 somewhat dissatisfied. This suggests that while the game engaged some students, it did not provide a consistently effective learning experience for all.

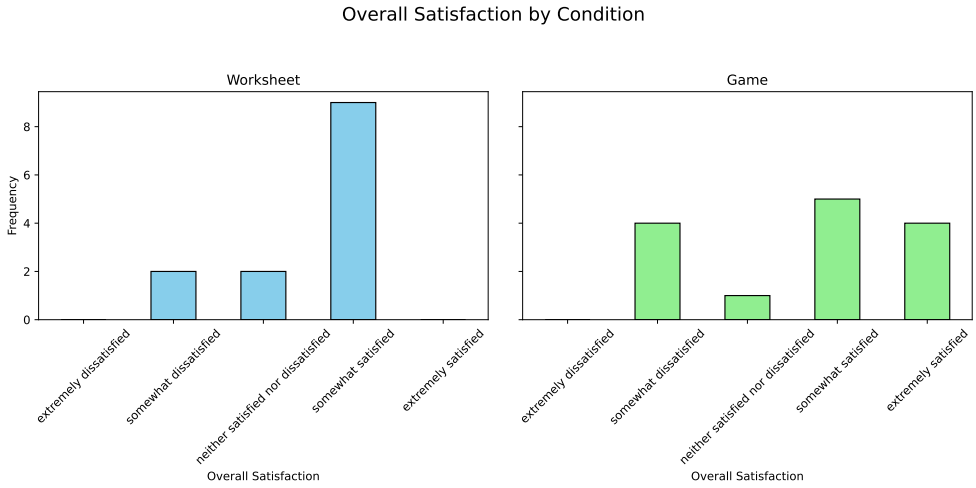

Figure 6: Satisfaction histogram

For game designers, the variability in participant satisfaction indicates that game mechanics may need

refinement to better support diverse learners. Some students responded positively to the interactive elements, while others were dissatisfied. Interestingly, the game condition produced several "extremely satisfied" respondents, hinting that certain students found the game highly motivating. Future research could explore how personalized feedback and progression systems affect engagement and learning outcomes.

In summary, while neither approach produced statistically significant gains, the trends in the data suggest that modifications in instructional strategies or game design may be necessary to boost rhythm-reading skills effectively. The mixed satisfaction ratings further emphasize the need for more tailored learning experiences to accommodate different learning preferences.

6 Conclusion and Future Work

This study found that a short, 30-minute session—whether a rhythm game or a worksheet—did not produce statistically significant gains in rhythm-reading accuracy, although participants generally reported positive impressions of both methods. Engagement and personal preference appeared to influence outcomes substantially, and our relatively small sample size may have limited the power to detect an effect.

Nonetheless, the game's interactive features and several "extremely satisfied" participants underscore gamification's promise as a motivational tool. Future investigations should incorporate longer practice durations, adaptive difficulty, and larger participant pools to clarify the game's effectiveness. By aligning rigorous pedagogical principles with refined game design, educators may help students maintain engagement while reinforcing foundational rhythm-reading skills.

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