MusiQuest Pilot Study

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Executive Summary

Edify Technologies, Inc. developed MusiQuest, a cloud-based software platform for teaching music. This online platform supports a teacher dashboard, student portal, and lessons intended for use at schools without a formal music program. MusiQuest was created partly through the support of the U.S. Department of Education's Small Business Innovation Research (SBIR) grant program. WestEd serves as the research partner for Edify Technologies and conducted two rounds of usability studies, a classroom feasibility study, and a pilot study for this SBIR Phase II grant. This report summarizes the findings from the pilot study.

For the pilot study, teachers were randomly assigned to treatment or control groups. Treatment teachers received training and were asked to assign and facilitate 10 MusiQuest lessons to their students, whereas control teachers taught as usual. Data collection included student pre-post surveys and knowledge assessments, teacher logs and surveys, observations, and usage data.

Some highlights of the findings included:

Treatment students showed significant gains in music knowledge, attitudes toward music, and musical confidence

The proportion of lessons completed correlated with post-assessment knowledge scores

Students enjoyed and were highly engaged when using MusiQuest

Teachers were able to implement MusiQuest as intended in the classroom

Areas for continued development of MusiQuest included:

Shorten the lessons overall while reducing character dialogue and adding more visuals and interactive components

Increase supports for English learners and students with varied reading levels

Provide additional teacher resources for those without music experience

Strengthen lesson completion points to avoid confusion

Add features to the teacher dashboard so they can better detect which students are progressing and who may need additional support

Study Overview

Edify Technologies, Inc. developed MusiQuest, a cloud-based software platform for teaching music. This online platform supports a teacher dashboard, student portal, and lessons intended for use at schools without a formal music program. MusiQuest was created partly through the support of the U.S. Department of Education's Small Business Innovation Research (SBIR) grant program. WestEd serves as the research partner for Edify Technologies and conducted two rounds of usability studies, a classroom feasibility study, and a pilot study for this SBIR Phase II grant. The research questions guiding the pilot study were:

1. How is MusiQuest, along with its key components of the leveled music creation interface and differentiated exercises, implemented in 3rd and 4th grade classrooms? Is it used with fidelity?

2. Does use of MusiQuest impact elementary students' musical skills and knowledge?

3. Does use of MusiQuest impact elementary students' attitudes toward music, the arts, or a career in the arts?

The pilot study utilized a randomized control trial design. WestEd recruited 38 public school elementary teachers from California and Maine who volunteered to participate in the study. Teachers were randomized into treatment and control groups based on their class grade level and whether their class participated in a schoolwide music program. Block randomization was used, meaning teachers were clustered into four groups and randomized within their group (Exhibit 1).

Exhibit 1. Randomization Clusters

	3rd Grade	4th Grade
No Schoolwide Music Program	Cluster 30	Cluster 40
Schoolwide Music Program Offered	Cluster 31	Cluster 41

Initially, 19 teachers were randomized into the treatment group and 19 were randomized into the control group. Five treatment and five control teachers dropped from the study due to various reasons and at differing points in the study, leaving a total of 28 participating teachers with 14 in each condition. The characteristics of the 28

participating teachers were reviewed to ensure the groups remained similar. Exhibit 2 presents the characteristics of the schools and teachers who participated in the study based on their assigned control or treatment condition.

Exhibit 2. Teacher Sample Characteristics

	Control	Treatment
Number of teachers	14 teachers	14 teachers
Number of teachers from schools with a music program	Yes: 3 teachers No: 8 teachers Hybrid: 3 teachers	Yes: 6 teachers No: 5 teachers Hybrid: 3 teachers
Grade level in 2023/24 school year	3rd grade: 8 teachers 3/4 grade: 1 teacher 4th grade: 5 teachers	3rd grade: 5 teachers 3/4 grade: 1 teacher 4th grade: 8 teachers
Teacher plays an instrument or has other musical skills/knowledge	No experience: 4 teachers A little experience: 5 teachers Moderate experience: 1 teacher A lot of experience: 4 teachers	No experience: 3 teachers A little experience: 4 teachers Moderate experience: 2 teachers A lot of experience: 4 teachers
Teacher experience teaching music	No: 12 teachers Yes: 2 teachers	No: 11 teachers Yes: 3 teachers

The 28 teachers represented 532 students who were included in the study sample. However, some parents opted their child out of the study and some students did not assent to their data being used in the analysis. Thus, usable data were obtained from 491 students, 255 from the control group and 236 from the treatment group. All students in the treatment classes were provided access and encouraged to use MusiQuest with their peers regardless of their participation in the study.

Teachers in the treatment group participated in a one-hour online training and were asked to assign 10 MusiQuest lessons to their students, covering the content of one module per lesson over a 10-week timeframe. Control teachers were asked to continue with their *business-as-usual* instruction.

For classes assigned to the treatment group, students were asked to complete a perceptions survey and music knowledge assessment before and after the intervention. Additionally, all treatment teachers were asked to complete a log for each lesson taught

as well as a post-survey upon study completion. WestEd researchers also conducted virtual classroom observations of implementation of a MusiQuest lesson and engaged in post-study interviews with a subset of the teachers in the treatment group. Finally, Edify provided WestEd researchers with select platform usage data, which further informed study implementation and findings.

Teachers randomized into the control group were asked to conduct their classroom instruction business-as-usual, with no supplemental music education or comparable intervention (other than what was already offered within the school). For most control classrooms, this meant no music education. Students completed a survey and music knowledge assessment at the beginning and end of the study implementation window. All control teachers were asked to complete a post-survey upon study completion.

See Appendix A for additional information about the study methodology, including instrumentation, sample characteristics, student characteristics, attrition, and data analysis techniques.

Study Findings

This section of the report presents the findings from the pilot study. Findings are presented by research question, followed by additional findings related to student engagement and the cost analysis portion of the study.

Findings for Research Question 1

Research Question 1 asked: How is MusiQuest, along with its key components of the leveled music creation interface and differentiated exercises, implemented in 3rd and 4th grade classrooms? Is MusiQuest used with fidelity and are teachers able to implement the music platform as intended? Findings for this research question were drawn from teacher logs, Edify usage data, teacher surveys, teacher interviews, and research observations.

Finding 1: MusiQuest was implemented as intended in the study plan with lesson completion time averaging about 30 minutes per lesson

Overall, MusiQuest was implemented as intended, and consistent with the implementation dosage outlined in the study plan. On average, teachers spent about 10 minutes outside of class preparing for each lesson. Teachers reported in the logs that on average, classes spent about five minutes on logistics (e.g., passing out computers, logging in, assessing lessons, closing out and returning computers). Across all lessons, teachers reported (from logs), on average, allotting about 39 minutes for each MusiQuest lesson. Teachers also spent about 11 minutes on average for other MusiQuest-related activities such as giving directions on expectations and MusiQuest features, or discussing with students after the lessons.

According to the teacher post survey, out of 14 treatment teachers, 11 teachers implemented MusiQuest lessons 1-2 times per week, and three teachers implemented the lessons 3-4 times per week because they got a later start or experienced delays so they completed more lessons in a week to catch up and finish implementation by the study deadline. Eleven teachers reported believing they were able to implement MusiQuest successfully in the classroom, as intended, and they found MusiQuest easy to implement with their students. According to teacher interviews, all teachers reported the students in their class were able to work on MusiQuest independently on their individual devices, and that the students often helped their peers or engaged in on-task discussions with one another.

Upon completion of each lesson, treatment teachers were asked to submit a lesson log providing details about how well the lesson worked, the amount of time it took to complete the lesson, and other lesson-based questions. Based on responses to the lesson logs, teachers reported spending an average of 40 minutes per MusiQuest lesson, with some teachers reporting up to 90 minutes for a given lesson. In particular, lessons 1, 3, and 4 appeared to take the most time to complete with some teachers reporting the lesson took up to 90 minutes (Exhibit 3).

Exhibit 3. Teacher Perceptions of Time Spent on MusiQuest Lessons (in minutes)

Project	Minimum	Average	Maximum
Lesson 1 – Welcome to Musi!	20	42.69	90
Lesson 2 – Exploring Musi	20	38.08	60
Lesson 3 – More, More, More Music	20	43.46	90
Lesson 4 – Expanding the Musical Medium	25	42.69	90
Lesson 5 – Easy Does It	25	35.77	45
Lesson 6 – Pent Up Energy	25	40.38	60
Lesson 7 – Sounds… Good?	25	37.00	60
Lesson 8 – Righting Wrong Notes	25	37.73	60
Average Across All Lessons	20	39.76	90

* Source: Lesson log responses from 13 treatment teachers.

Teacher perceptions of time spent on lessons was much higher than the actual time students spent engaged in each MusiQuest lesson based on usage data obtained from Edify; however, teacher perceptions likely included setup time, an introduction to the lesson, and closing time or discussion after the lessons. On average, students spent about 29 minutes per MusiQuest lesson, although these numbers are slightly inflated due to outliers who may have remained logged into a lesson beyond the time it took them to complete the lesson, as evidenced by the maximum time spent on any given lesson of 640 minutes (Exhibit 4).

Exhibit 4. Student Time Spent on MusiQuest Lessons (in minutes)

Project	Minimum	Average	Maximum
Lesson 1 – Welcome to Musi!	0	24.31	246
Lesson 2 – Exploring Musi	0	26.77	290
Lesson 3 – More, More, More Music	0	22.96	93
Lesson 4 – Expanding the Musical Medium	2	35.65	391
Lesson 5 – Easy Does It	0	37.29	296
Lesson 6 – Pent Up Energy	0	38.06	640
Lesson 7 – Sounds… Good?	0	24.77	146
Lesson 8 – Righting Wrong Notes	0	10.44	131
Average Across All Lessons	0	28.65	640

* Source: Edify usage data.

In addition to looking at the time spent on lessons, we also reviewed the average time spent on MusiQuest lessons by individual class. Exhibit 5 presents a graph plotting the average time each class spent engaged on MusiQuest lessons. The graph shows that although a few classes spent more or less time using the platform, most classes completed the lessons within the 25-35 minute range, which was consistent with the average of 29 minutes per lesson.

Exhibit 5. Plot of Average Time on Lessons by Class
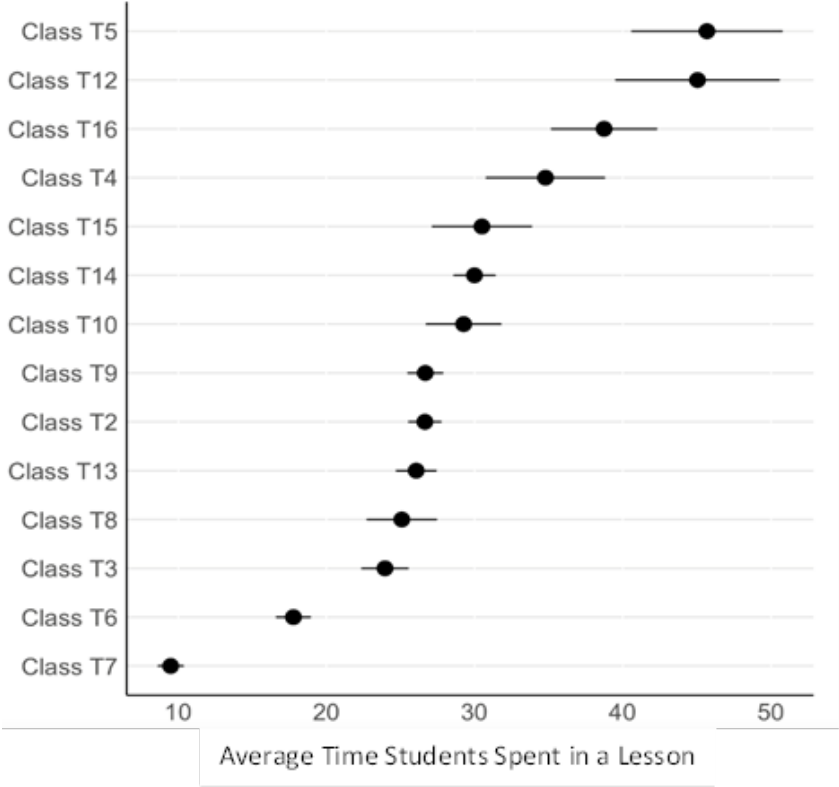

Average Time Students Spent in a Lesson

Exhibit 6 presents the average proportion of the lessons completed across the eight MusiQuest lessons, aggregated by classes. This is the average proportion of components students completed within a each lesson, aggregated across lessons 1 through 8. Overall, about one-third of classes averaged 90% or greater completion for the MusiQuest lessons and three classes averaged less than 50% completion. For any given lesson, on average the student completion rate was approximately 80% of the lesson.

Exhibit 6. Proportion or MusiQuest Lessons Completed

Average Proportion of a Lesson Completed
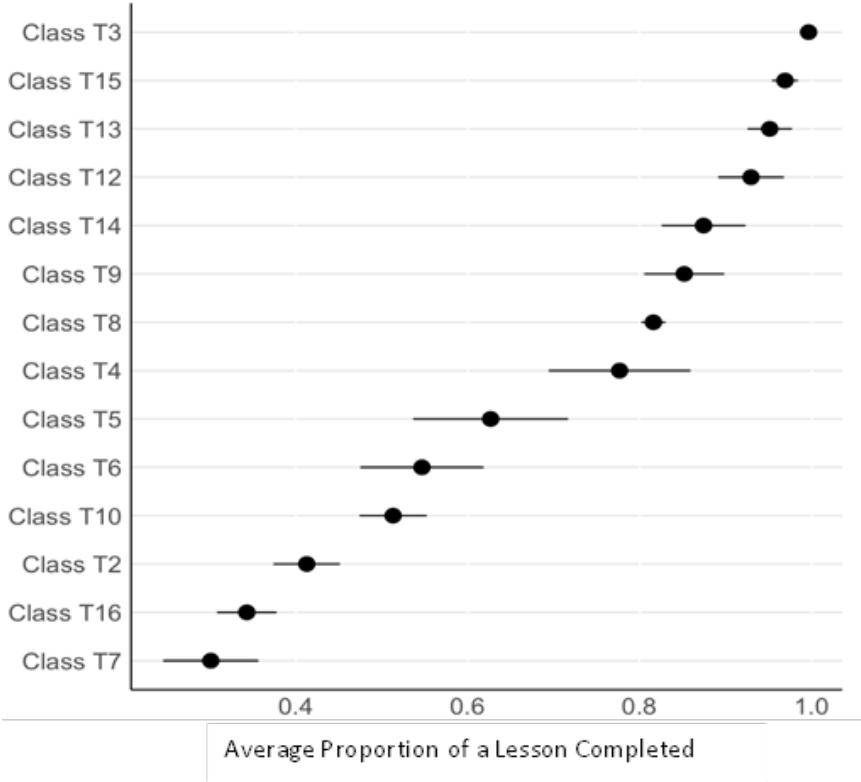
Teacher lesson logs captured data regarding what the teachers were doing as their students were engaged using the MusiQuest platform and completing lessons. Teachers were presented a list of activities and were able to select all that applied during the lesson. The most common activities teachers engaged in were directly related to MusiQuest. Specifically, teachers usually answered questions about MusiQuest vocabulary or content (65 log responses) and troubleshoot technical or logistical issues related to MusiQuest (64 log responses). In some cases, students worked on MusiQuest independently allowing teachers to engage in other activities unrelated to MusiQuest (42 responses). Although not a requirement of the study, teachers also reported facilitating discussions about the MusiQuest lesson to extend or enhance student learning, such as connecting the music lesson with content students were learning in other subjects. Exhibit 7 presents teachers responses based on the lesson logs.

## Exhibit 7. Teacher Activities during MusiQuest Lessons
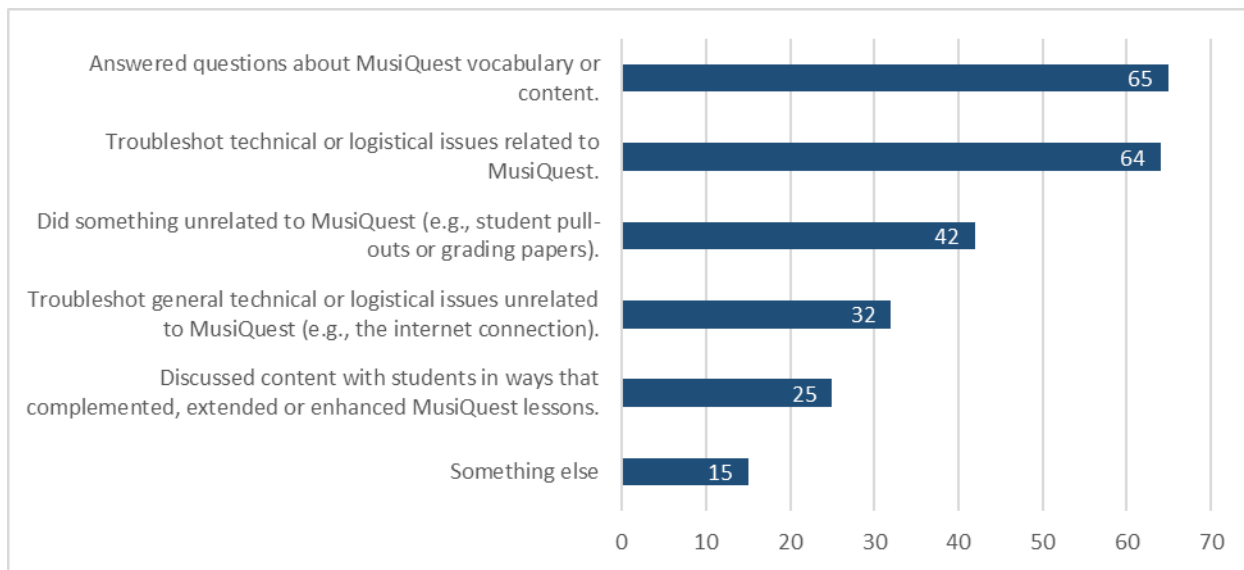
Finding 2: Teachers report that students found MusiQuest easy to use

Overall, teachers said their students enjoyed using MusiQuest and found MusiQuest easy to use despite some technical or usability issues as reported in the lesson logs and the post-interviews. More than 80% of teachers agreed or strongly agreed their students enjoyed MusiQuest lessons, understood how to use and work through the MusiQuest lesson, and thought MusiQuest was easy to use. However, slightly over 20% of teachers agreed or strongly agreed that their students had a lot of technical issues with MusiQuest, although nearly 20% also strongly disagreed that their students had a

lot of technical issues with MusiQuest. Exhibit 8 shows a summary of teacher responses related to ease-of-use from each lesson's teacher log.

Exhibit 8. Classroom Attitudes and Ease of Use for Students
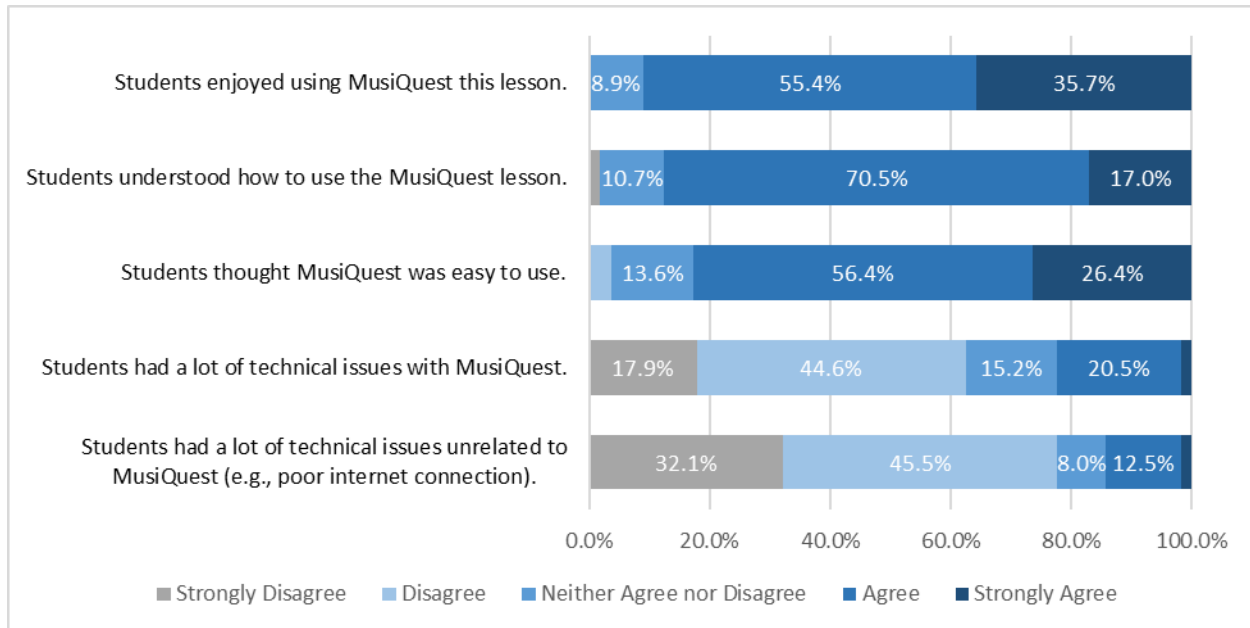
The ease of use of MusiQuest was also evident in the qualitative data. All teachers reported MusiQuest was easy to implement in the classroom, and that students were able to work independently as intended. One teacher shared appreciating that she "didn't have to lesson plan" and that "[the lesson] was all there for me; it just ran smoothly." Another teacher reported:

> *"It was pretty easy [to implement]. Sometimes there were a few students who had a problem, and someone else [i.e., another student] would come in and help them and they would be fine."*

Teachers also pointed to high student engagement (further discussed later in the report) as a contributing factor to the overall success and ease of MusiQuest implementation. For example, one teacher observed "there were no classroom management issues [when implementing MusiQuest], which usually arises when the activity is boring." Teachers also noted how on-task teamwork and conversations often took place when students were using MusiQuest, indicating high student engagement. One teacher mentioned, "There was a lot of appropriate chatting… [and] a lot of team-building and helping; and conversations that were on topic." This teacher went on to say how the student collaboration and teambuilding was "one of my favorite parts of the program."

Finding 3: Teachers predominantly scaffolded independent use of MusiQuest

Teachers described their main role in the classroom to predominantly be scaffolding the use of MusiQuest and providing support by walking around the classroom and helping where needed. Teachers either briefly introduced the lesson at the beginning of each session, or facilitated a whole class debrief in which students would share out what they learned or what they liked and did not like about the lesson. One teacher mentioned she always went through the music vocabulary with her students before they dove into the lessons. Another teacher explained how she introduced the lesson by "telling the students what they were going to be working on in the lesson" and "giving them the information to log in if they forgot it," reinforcing MusiQuest as a tool feasible for independent student use.

Other than some scaffolding and facilitation provided by teachers, students mostly worked independently and asynchronously on their own as facilitated by the MusiQuest platform. Teachers noted that once students were working independently after answering a few questions, they then were able to work on their own lesson preparation, grading, or other activity. For example, one teacher described her role during a typical implementation session, sharing, "During the lessons, I just walked around and saw what the kids were doing… When I wasn't doing that, I was at my desk either preparing for something else, or I was checking for whether a student was done."

When asked about preparing for the lessons, most teachers noted they prepared mainly by reviewing the provided Lesson Preview, which took approximately 10-15 minutes or preparation time. Most teachers found the Lesson Preview helpful, although some teachers recommended making the materials more digestible and less text heavy. Overall, teachers appreciated how they could achieve other things while their students were working independently on the MusiQuest lessons.

Finding 4: Teachers felt comfortable supporting students' music learning, regardless of their own music background

In the last lesson log, treatment teachers were surveyed about their personal sense of efficacy in teaching music. Teachers provided overwhelmingly positive responses regarding these questions. More than three-quarters of the teachers agreed or strongly agreed with each of the statements (Exhibit 9) despite the majority of teachers having limited prior experience teaching music. It is important to note these prompts were only

asked after teachers used MusiQuest with their students (as opposed to both before and after). As such, it is unknown whether MusiQuest made an impact on teacher sense of self-efficacy about teaching music and this should be further examined in future studies. However, the results from this sample suggested teachers were comfortable with supporting their students to learn music through the MusiQuest platform.

Exhibit 9. Teacher Self-Efficacy Regarding Teaching Music
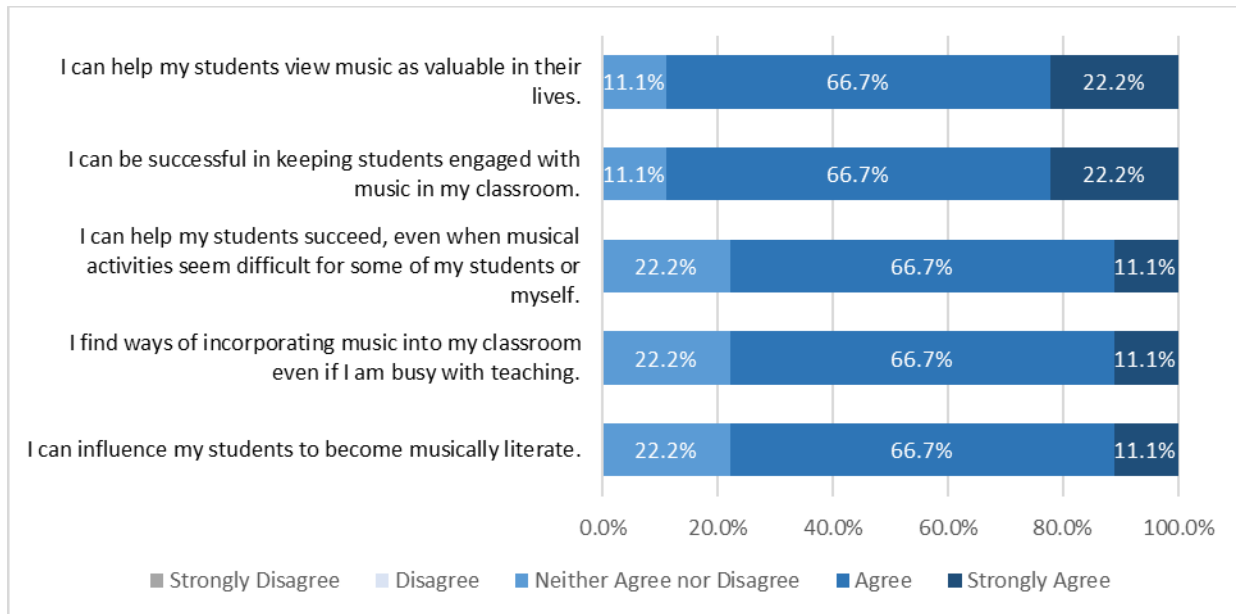
Finding 5: Teachers noted some challenges in implementation

Although teachers generally believed MusiQuest was easy to use and they successfully implemented it with their students, teachers also noted a few challenges they experienced.

First, some classrooms experienced general confusion regarding lesson completion for both teachers and students. One teacher reported many students in her class were unclear on when or where each lesson ended, as they were not able to experience a clear visual marker for when the lesson was completed. She expounded:

"Every session they came up to me. Almost every time it happened, they would say, 'I think I'm done,' but I would check and it would not show that they were done on the dashboard side. That happened almost every lesson where students were confused whether they completed a

lesson… There wasn't something clear to them that said they had completed the lesson. There wasn't a clear sequence for them… There wasn't anything that clearly stated that they were done, there was no bar graph for example that showed them that they were 50% done, or something like that."

Other teachers reported similar challenges with students not knowing when they were finished with the lesson, and the teacher would have to check the dashboard to let the students know. One teacher explained there was no clear demarcation of when each lesson was done, and that some of the activities came across as repetitive so students were not certain if they were repeating a lesson.

Second, some teachers reported challenges with overall lesson pacing and time management, with some students who were spending additional time on each lesson whereas other students progressed forward. One teacher reflected,

"After the first lesson I felt like everyone was at a different place in the lesson."

This impacted how the teacher felt she could facilitate an effective introduction to each lesson, because all her students were at different parts of the lesson.

Finding 6: Teachers found starting initial use of MusiQuest easy and valued the teacher resources

In the teacher log for the first lesson, teachers were asked questions related to the onboarding process and asked about their first time using MusiQuest. Teachers had positive responses overall. All teachers agreed or strongly agreed that it was easy for students to log into MusiQuest the first time and all but one indicated the initial training and introduction to MusiQuest was helpful (Exhibit 10).

Exhibit 10. Teacher Initial Onboarding and Use of MusiQuest
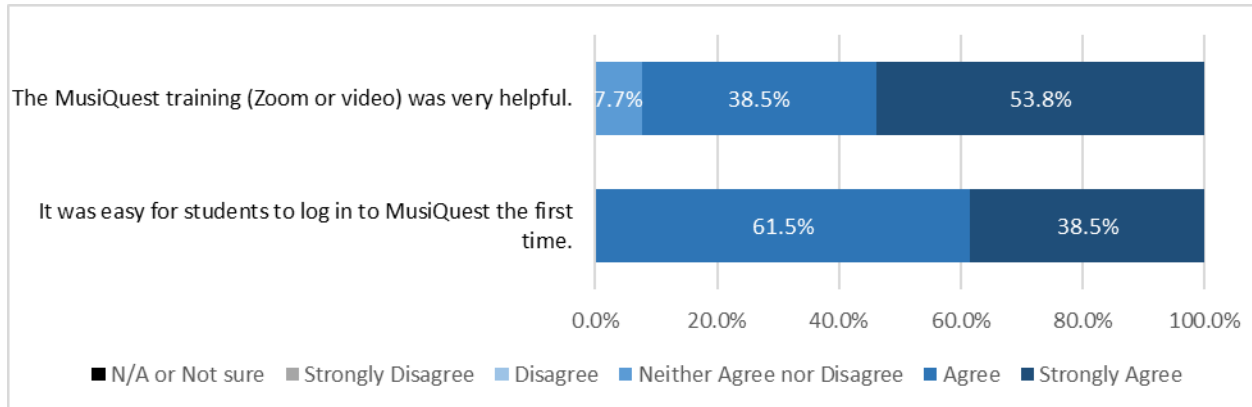
Teachers were also asked to rate the helpfulness of various resources in each lesson's teacher log, with the results aggregated across lessons. Teachers particularly valued the Teacher Dashboard, with 84.1% of responses indicated it was helpful or very helpful. Teachers also valued the Lesson Preview page, with three-quarters of responses noting these resources were helpful (Exhibit 11).

Exhibit 11. Teacher Use and Rating of Various Teacher Resources
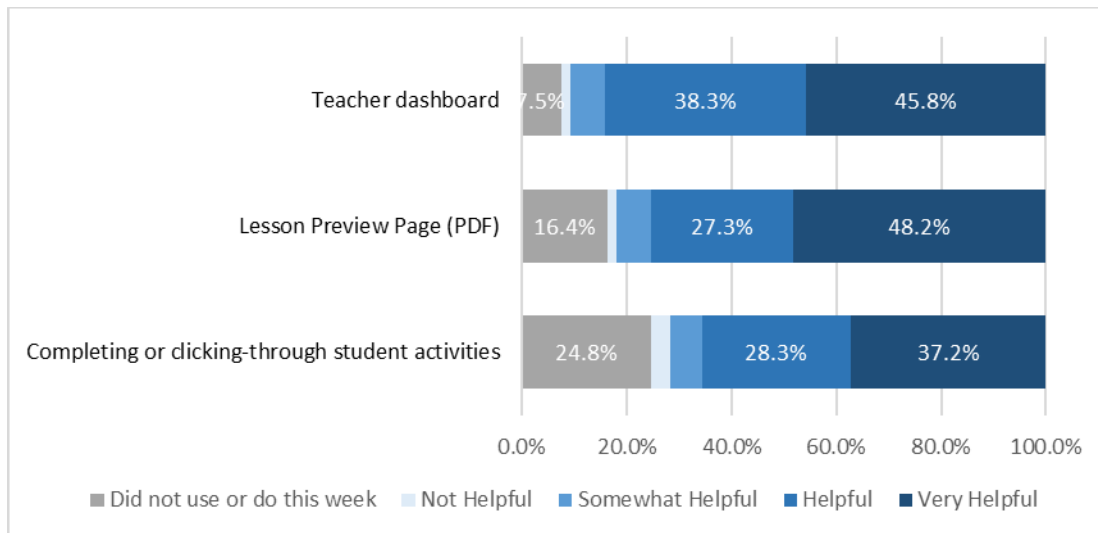
Additional data about teacher use and impressions of the resources were collected during interviews and through the post-survey. According to interviews, teachers primarily used the dashboard to track student progress and assign lessons. One teacher described her use of the dashboard, saying:

> *"I was constantly look at where my kids were at, [whether] they completed something…I was constantly on there looking on their activities and so on."*

Teacher Dashboard. In the post survey, all treatment teachers thought the dashboard was somewhat or very helpful for implementing MusiQuest. Twelve of the 14 teachers found the dashboard somewhat or very easy to use. Regarding the amount of time spent using the teacher dashboard, responses varied. Approximately one-third of teachers spent 1-5 minutes using the dashboard, another one-third spent 6-10 minutes, and the remaining one-third spent 16-20 minutes. Only one teacher reported not typically using the dashboard.

Teachers also offered ideas for potential additions and enhancements to the teacher dashboard. One teacher thought the dashboard could offer more information overall. She suggested:

> *"I think the dashboard…could offer more information that could help monitor student learning, maybe even student growth – for example, if they take assessments within the program, seeing that data would help."*

Some teachers also reported confusion about using the teacher dashboard. One teacher described how the navigation was not completely clear and she had to "constantly reminding myself where to go" despite using the dashboard often. Another teacher experienced challenges finding what lessons she needed to assign because there were "a lot of places to go" and "it felt very wordy on the side bar." She suggested condensing the menu items to have fewer things available for users to click on. She also enjoyed the instructional videos and suggested including more tutorials with instructional videos and visuals for using the dashboard. Finally, one teacher suggested including an alert button on the student-facing platform to notify the teacher if the student was stuck, or rapidly skipping through the lesson. This teacher explained:

> *"The only way that I knew that a student was skipping through the lessons was when I was walking around and saw the students skipping through. It would have been nice if on the dashboard an alert came up [notifying me] of that, or that they needed help. I wouldn't have known if a student didn't come up to me."*

Lesson Previews. During interviews, teachers reflected mixed reactions regarding the Lesson Preview documents, although most teachers considered these helpful overall. One teacher expressed finding them "really helpful" and another teacher commented feeling the lesson plans were clear and she wanted the Lesson Previews to be integrated as a part of the curriculum overall.

However, some teachers considered this resource to be less helpful, citing the pages were a little too text heavy. For example, one teacher suggested modifying this resource so it contained more visuals and was more easily digestible. She shared how the previews were not clear and how she would have benefited from a short video walkthrough. She also suggested including ways teachers could better support student understanding, such as offering definitions of terminology or providing discussion questions teachers could use to expand student thinking.

Finding 7: Capstone Concerts were a hit among teachers and students

According to the teacher logs, 10 out of 14 treatment teachers organized the capstone concert for their classes. Nine teachers completed a lesson log for the capstone concert; thus, the quantitative findings related to the capstone project is based on nine teacher responses.

Overall, teachers spent an average of 31 minutes preparing for the capstone concert. In addition, they spent about 5 minutes on logistics, 44 minutes on the concert itself, and 8 minutes for other related activities such as organizing students to assist each other with saving songs or having students finish their songs. During the concert, six teachers reported discussing the content with their students and five answered questions related to vocabulary/content or troubleshot issues related to MusiQuest (Exhibit 12).

Regarding student engagement with the capstone concert, 7 of 9 teachers reported their students were engaged or very engaged in the capstone concert. On the student post-survey, students also gave an average score of 8 out of 10 when asked to rate how they liked creating the capstone project.

Exhibit 12. Teacher Activities during the Capstone Concert
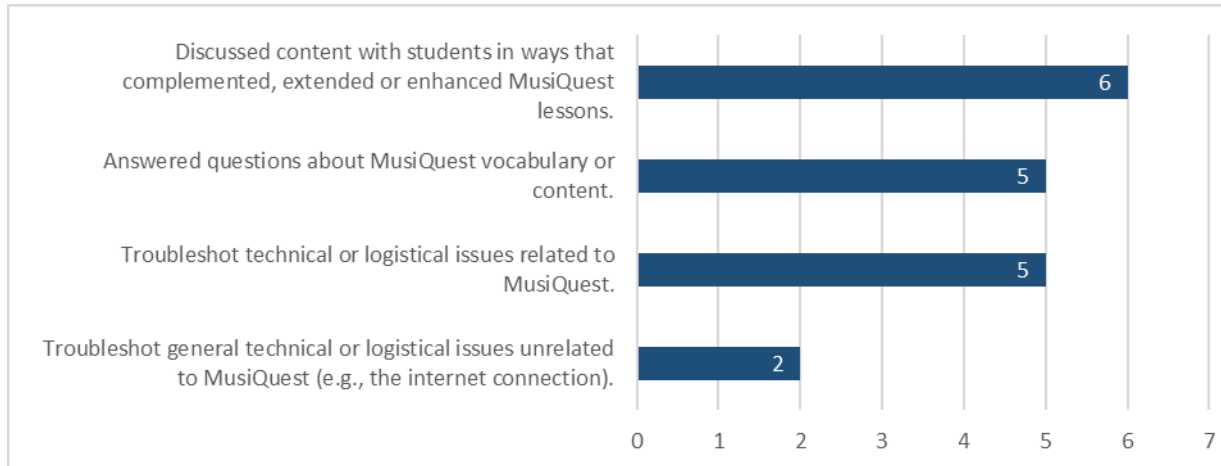
According to teacher interviews, teachers found the Capstone Concert easy to implement and highly engaging, and students had a lot of fun creating and sharing their capstone concerts. One teacher noted the directions were clear and she appreciated the collaborative nature of the assignment. With regards to student engagement, another teacher shared how students were excited to create their songs throughout the entire lesson sequence and wanted to share what they were making. Another teacher said her students were "very engaged and excited" while working on their Capstone Concerts, describing:

> *"They were screaming and cheering for each other, very loudly – 'bravo!' Some kids changed their name on their songs—that made everyone else excited. [I heard students saying things like] 'I like your song', or 'you could add this next time or do this.'"*

Despite the overall success of the Capstone Concert, some teachers cited some challenges with organizing the capstone concert. For instance, one teacher mentioned the Capstone Concert took longer time to prepare, because "putting everything together was trickier" than expected. In the end, she had the students go to each other's stations to listen to everybody's songs and then provide a critique. Regardless of the few challenges experienced, overall teachers and students appreciated the Capstone Concert and enjoyed hearing the students' creations.

Findings for Research Question 2

Research Question 2 asked: Does use of MusiQuest impact elementary students' musical skills and knowledge?

Finding 1: Treatment students scored significantly higher on the post music knowledge assessment

The sample for the student knowledge assessment comprised of 491 students, with 255 control students and 236 treatment students. A preliminary analysis examining pre-test differences was first conducted to evaluate whether group differences were present between the treatment and control groups prior to the start of implementation. The baseline differences between groups on the pretest was -0.02 standard deviations, which was negligible and indicated control students scored slightly higher than treatment students (Exhibit 13).

Exhibit 13. Pre-Assessment Baseline Equivalence

Condition	Mean	SD	n	Hedge's g
Control	8.32	3.44	255	-0.02
Treatment	8.26	3.27	236	

A two-level mixed effects linear regression was employed to account for the nesting of students within teachers (a random effect) and included fixed effects for condition (treatment/control), pre-test, grade, and the randomization block.

The central variable of interest in the impact model is the Treatment variable, which indicates whether MusiQuest had an effect on student knowledge while accounting for the other variables. Positive coefficients for this variable indicated a higher post-test score for treatment students. The coefficient value estimates indicate the average difference in the treatment group's post-assessment scores relative to the control group, given that the groups were equivalent prior to the intervention (Exhibit 14).

Exhibit 14. Assessment Impact Model

Survey Scale	Estimates	SE	t-value	d.f.	p
(Intercept)	3.53	0.53	6.65	48.07	0.00
Treatment	1.10	0.45	2.46	18.96	0.02
pre	0.58	0.04	14.32	472.02	0.00
grade4	1.41	0.97	1.44	258.69	0.15
Cluster31	-0.07	0.62	-0.11	19.76	0.92
Cluster40	-1.00	1.08	-0.93	84.13	0.36
Cluster41	0.62	1.10	0.57	77.32	0.57

The control group's mean score increased from 8.32 to 9.02 whereas the treatment group's mean score increased from 8.26 to 10.12. In this model, the Treatment variable indicates that **the treatment group had a statistically significant higher post-test score** relative to the control group ($p < 0.05$) at an effect size of 0.298 (Exhibit 15).

Exhibit 15. Assessment Hedge's g Effect Size and Statistics

Condition	Mean	SD	n	Hedge's g	95% CI
Control	9.02	3.44	255	0.298	0.12, 0.48
Treatment	10.12	3.94	236		

* p values calculated using Satterthwaite d.f.

In practical terms, on average, going from the control to the treatment condition results in a 1.1 change in post-test score, or a 5.5% improvement (Exhibit 16).

Exhibit 16. Adjusted Means of Student Post-Assessment Scores
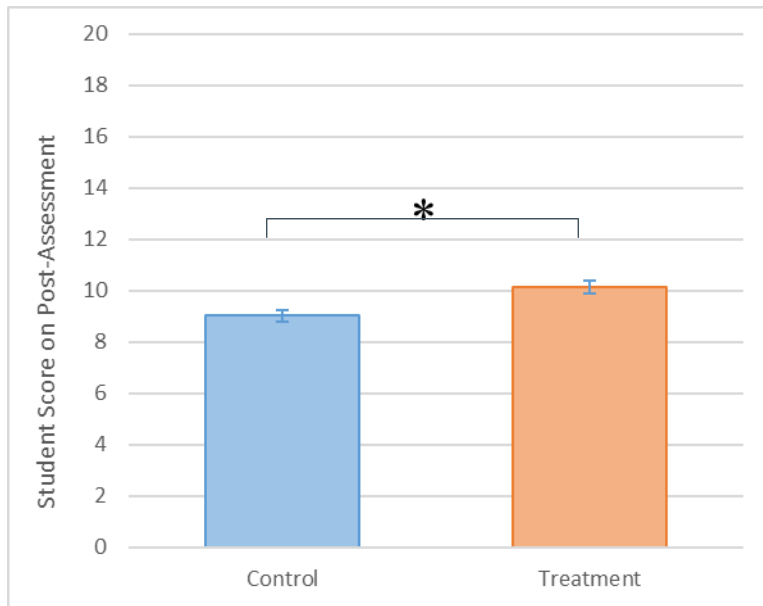
The results showed statistically significant, positive effects for the MusiQuest program on student musical knowledge. Participating in the treatment group resulted in an average increase of .30 standard deviations relative to the control group on the researcher-developed assessment.

We also conducted moderator analyses for grade, gender, students' previous music experience, pre-score, and school music program status. Although we did not find statistically significant effects at the alpha < .05 threshold for any moderating variables, we note that students' music experience and whether the school had a music program showed a trend for moderation effects. Specifically, treatment effects were larger for students who had at least some prior music experience (Exhibit 17) and for schools that had a school music program (Exhibit 18). Because we were underpowered to detect these effects, we do not make definitive conclusions about these interactions, but rather note these trends for future research to consider.

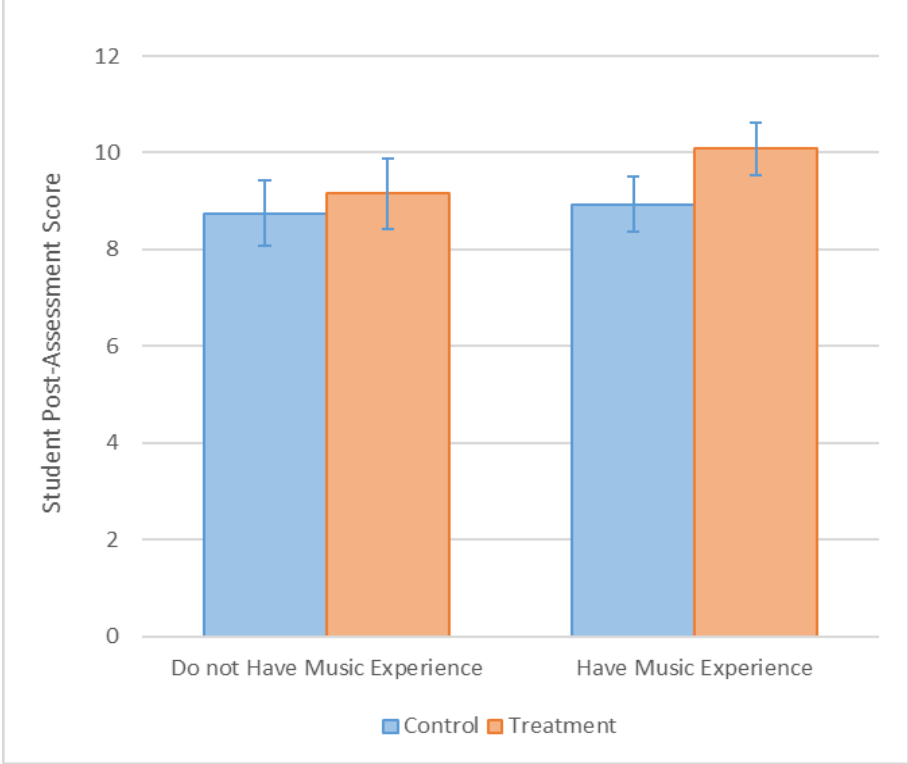## Exhibit 17. Student Music Experience and Post-Assessment Interaction Effect

Exhibit 18. Music Program Availability and Post-Assessment Interaction Effect
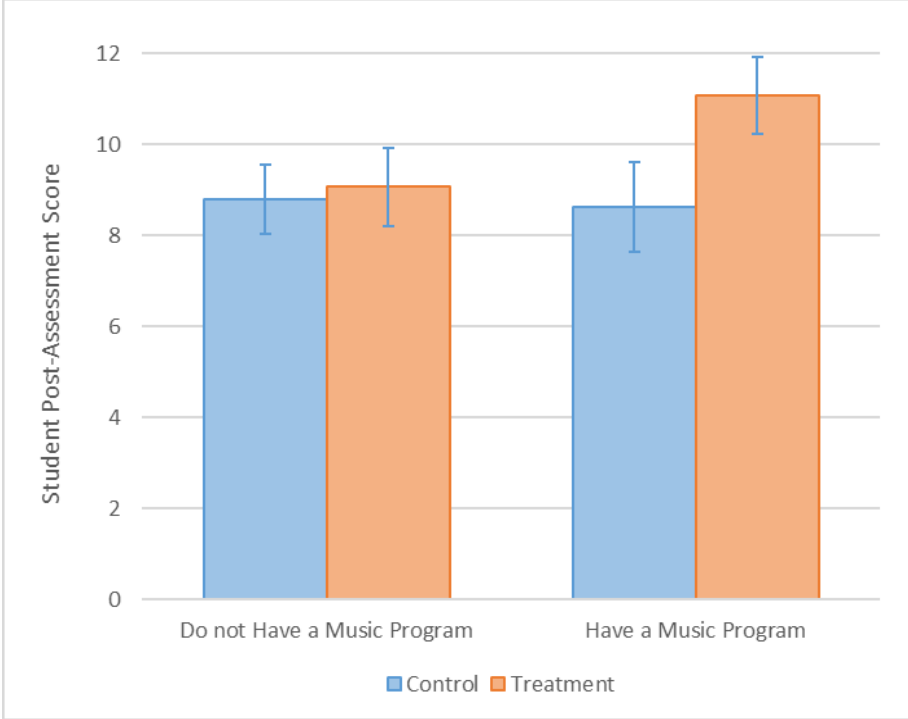
Finding 2: A small positive correlation was found between the proportion of lessons completed and the student post-assessment score

In addition to conducting the impact model, we also computed Pearson's product-moment correlation to explore whether there was any relationship between student use of MusiQuest and student post-assessment score. The result showed a small but statistically significant and positive correlation between the average proportion of lessons completed and student post-assessment scores (correlation coefficient = .361, $p < .05$). Exhibit 19 shows the plot of the correlation. Correlations are not causal evidence; thus, further investigation is necessary to determine whether the usage itself is directly responsible for increased post-scores. However, coupled with the significant treatment effect relative to the control group, these results are consistent with the notion that the more MusiQuest lessons that students complete, the higher their post-assessment scores tend to be.

Exhibit 19. Correlation between Average Proportion of Lessons Completed and Student Post-Assessment Scores
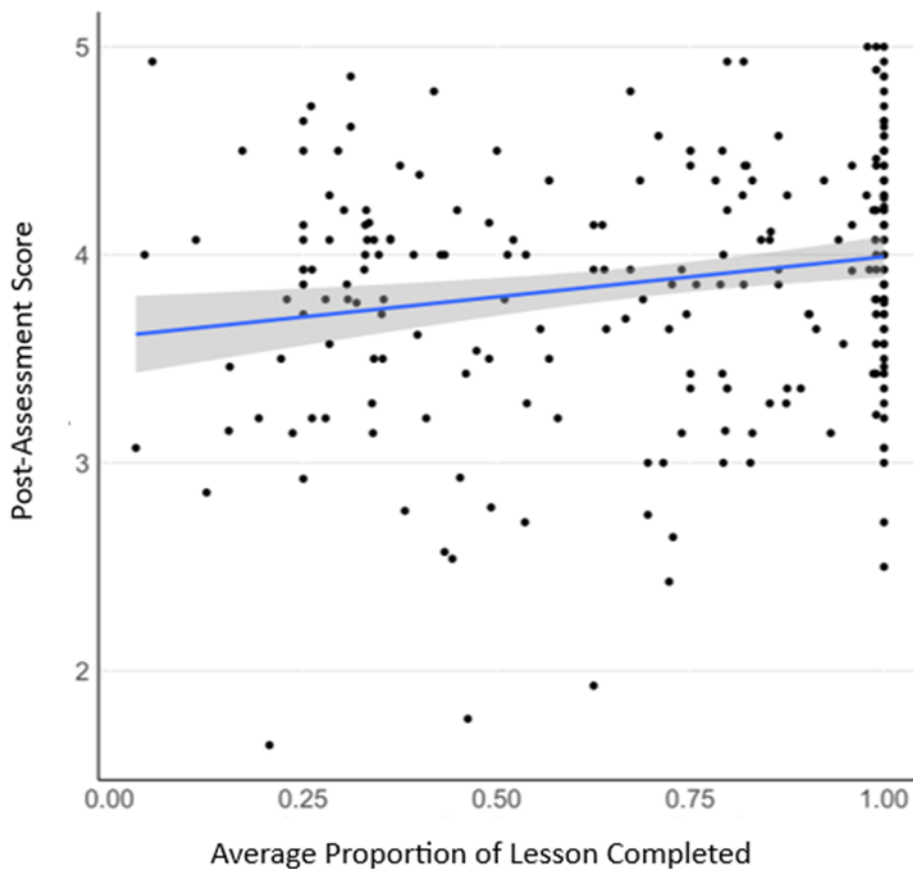
Finding 3: Teachers and researchers observed evidence of student learning

As the quantitative evidence suggested, MusiQuest positively impacted elementary students' musical knowledge. This was also corroborated by the qualitative data from teacher surveys and research observations.

For some students, MusiQuest was their first exposure to music education. MusiQuest provided introductory knowledge of music by teaching students about musical notes, consonance, dissonance, rhythm, melody, tempo, tone, pitch, sheet music, different kinds of instruments and sounds, music from diverse cultures, different music genres, and how to make music. Teachers observed that students remembered specific musical knowledge and used the terminology, like the pentatonic scale, and demonstrated their new music knowledge and skills during in their capstone pieces. Teachers believed simply exposing students to music was a huge asset and benefit as a learning tool. One teacher shared:

> *"I think they gained a deeper understanding of the different components of music, like bass and tempo, that I don't think they would have been able to as in-depth prior."*

Through MusiQuest, students were given the opportunity to explore music in ways they were unable to before gaining access to the platform. Being able to experiment with different instruments, tones, and sounds was enriching for students. One teacher explained:

> *"MusiQuest opened their eyes to what music could be for students. It broadened their understanding but also their willingness to listen to different kinds of music."*

Teachers had positive perceptions of MusiQuest's impact on student knowledge and musical skills. A majority of teachers indicated that MusiQuest had a positive impact on both student music knowledge (92.9%) and skills (92.4%). Breaking it down further, teachers believed MusiQuest had a greater impact on student knowledge than music skills, with 64.3% of teachers indicating MusiQuest had a very positive impact on student knowledge compared to 46.2% of teachers indicating a very positive impact on musical skills (Exhibit 20).

Exhibit 20. Teacher Perceptions of MusiQuest Impact on Students

Student knowledge	7.1%	28.6%	64.3%
Student musical skills	7.7%	46.2%	46.2%

Legend: ■ Very negative impact ■ Slightly negative impact ■ No impact ■ Slightly positive impact ■ Very positive impact
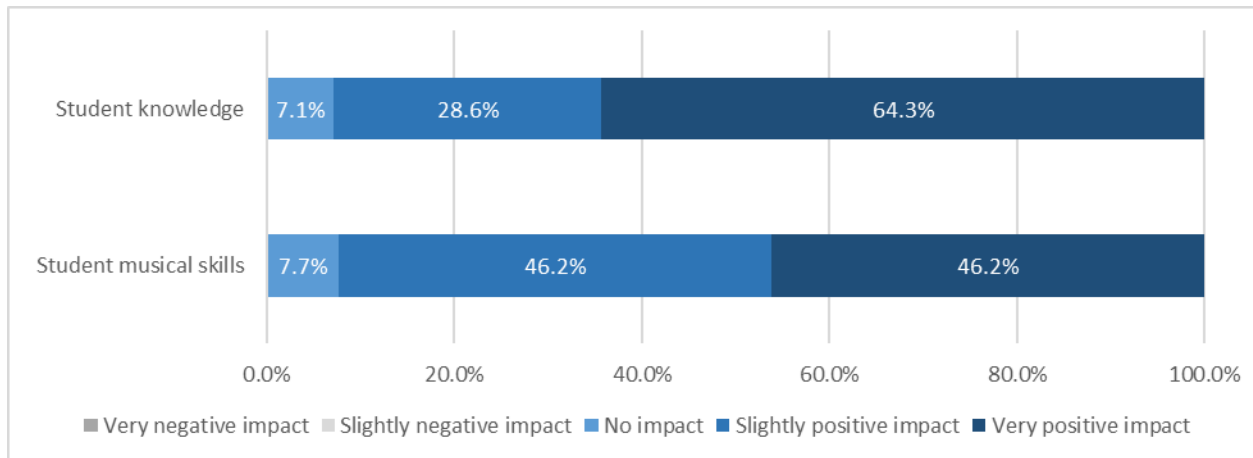
* Source: Teacher post survey.

MusiQuest introduced students to new music vocabulary, which students then used in class. Teachers also noted students would recognize and use vocabulary they learned from MusiQuest in other parts of class, such as reading or math instruction, and mention the connection.

For students with access to a schoolwide music education program, teachers talked about student enthusiasm in cross-application, taking what they learned from MusiQuest to music class and vice versa. Students participating in school music programs were able to transfer the knowledge they learned in MusiQuest and apply it to band or other music classes. Even for students who were not in band, they were excited about being able to create music. For example, one teacher mentioned her students that used MusiQuest demonstrated a more advanced knowledge of music in their music classes, which impressed their music teachers. This highlighted the benefit of MusiQuest even for those schools with a formal music program.

Students also expressed how they learned more about music. When teachers asked at the end of class what they learned, students shared that they learned to make sounds and create music. One teacher said:

> *"One of my students is challenged with reading and following directions. He was not able to tell me what was being asked for him to do, but he was able to explain how music changed by describing how the bars can be moved up and down and how a bar can be stretched and as a result how the sounds of music can be modified."*

Despite many positive comments from some teachers, other teachers expressed they were unsure how well their students actually learned from the MusiQuest content. Teachers recognize that there was learning happening, but it is difficult for them to discern the extent to which the MusiQuest content fostered learning musical skills.

Finding 4: The impact of MusiQuest on English learners and those with lower literacy levels is uncertain

In the teacher logs, 90.1% of teachers either agreed or strongly agreed it was easy for students fluent in English to understand the lesson context, language, and vocabulary. For English learners, this number dropped to 68.0% (Exhibit 21). One teacher described her English learners experience engaging with MusiQuest, sharing:

> *"They would struggle and say, 'what do I do here?'...Students whose reading and writing was low, they were really stuck and they were like 'I don't know what to do here, I don't know what to put here, I don't know what this says.'"*

Teachers noted that English learners found it difficult to understand the MusiQuest content and it was challenging for the teachers to help struggling students because they themselves were unfamiliar with the exact content the platform was presenting to students. Despite the language barriers, English learners enjoyed engaging with the Song Builder feature and found it accessible for students with little to no English.

Exhibit 21. MusiQuest Impact on Knowledge from Teacher Post
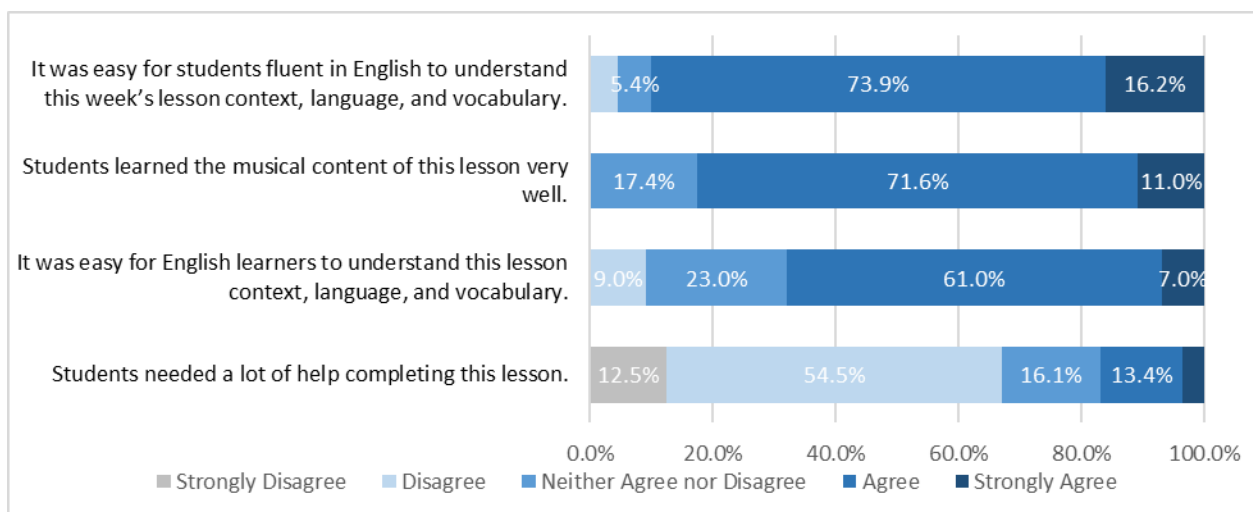
* Source: Lesson logs by 13 teachers for lesson 1 through 9.

Findings for Research Question 3

Research Question 3 asked: Does use of MusiQuest impact elementary students' attitudes toward music, the arts, or a career in the arts?

The student attitudinal survey consists of three separate subscales: Student Achievement Motivation, Student Confidence with Music, and Student Creativity. In this section, we present findings regarding the attitudinal survey overall scale, which includes all survey items, and each of the three separate subscales. To forecast, we find a statistically significant effect of the treatment on student post survey overall score and post confidence subscale score.

Finding 1: Treatment students reported more positive attitudes toward music

The sample for this analysis consisted of 517 students, with 262 students from the control group and 255 students from the treatment group.

Baseline equivalence testing was conducted to determine whether a difference between treatment and control students' attitudes toward music existed at the beginning of the study, prior to any engagement with the MusiQuest platform. The baseline differences between groups on the pre-survey overall was 0.14 standard deviations, which is considered within the range of statistical correction to satisfy baseline equivalence (Exhibit 22). The overall mean score for treatment students (3.76) was slightly higher than that of control students (3.67). This was accounted for in subsequent analyses.

Exhibit 22. Pre-Survey Overall Baseline Equivalence

Condition	Mean	SD	n	Hedge's g
Control	3.67	0.52	262	0.14
Treatment	3.76	0.59	255	

A two-level hierarchical model accounting for nesting of students within teachers (a random effect), including fixed effects for condition, pre-survey, grade, and randomization block, was conducted to determine whether there were differences between treatment and control groups. This model indicated a statistically significant difference between the adjusted means of the treatment and control group post-survey overall scores ($p < .05$) with an effect size of 0.33. The model estimated that on

average, going from the control to the treatment condition resulted in a 0.2 change in student post-survey overall score (Exhibit 23).

Exhibit 23. Survey Overall Impact Model

Survey Scale	Estimates	SE	t-value	d.f.	p
(Intercept)	1.47	0.16	9.20	317.57	0.00
Treatment	0.20	0.06	3.14	19.06	0.01
pre	0.60	0.04	14.82	507.57	0.00
grade4	-0.26	0.16	-1.60	162.22	0.11
Cluster31	-0.02	0.09	-0.22	19.90	0.83
Cluster40	0.16	0.17	0.95	78.53	0.35
Cluster41	0.31	0.18	1.77	74.60	0.08

* Statistically significant result

The control group's mean rating decreased slightly from 3.67 to 3.66 whereas the treatment group's mean score increased from 3.76 to 3.86. In this model, the Treatment variable indicated that **the treatment group had a statistically significant higher post-test rating** relative to the control group ($p < 0.05$) at an effect size of 0.33 (Exhibit 24).

Exhibit 24.Survey Overall Hedge's g Effect Size and Statistics

Condition	Mean	SD	n	Hedge's g	95% CI
Control	3.66	0.61	262	0.33	0.16, 0.50
Treatment	3.86	0.60	255		

Exhibit 25 displays the adjusted means of the overall student survey ratings for both the control and treatment group.

Exhibit 25. Adjusted Means of Student Post-Survey Overall Scores
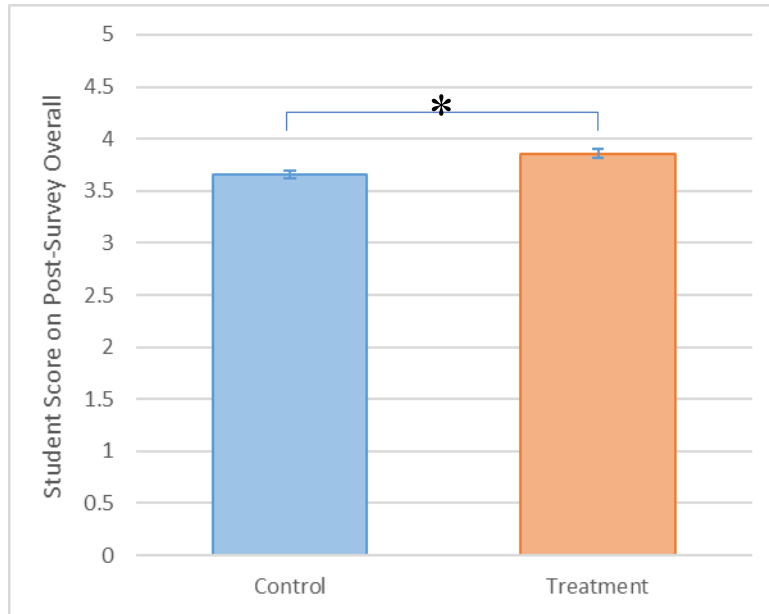
* p values calculated using Satterthwaite d.f.

Finding 2: Treatment students reported significantly higher levels of confidence after using MusiQuest

The analytic sample for the student confidence subscale consisted of 516 students, including 261 students from the control group and 255 students from the treatment group.

Preliminary analyses were conducted to evaluate the baseline equivalence between the treatment and control group. The baseline differences between groups at pre-test was 0.15 standard deviations, which is considered within the range of statistical correction (Exhibit 26). This is accounted for in subsequent analyses.

Exhibit 26. Pre-Survey Confidence Subscale Baseline Equivalence

Condition	Mean	SD	n	Hedge's g
Control	3.26	0.74	261	0.15
Treatment	3.37	0.75	255	

A two-level hierarchical model was used to assess differences between the treatment and control groups, considering the nesting of students within teachers (a random effect), and fixed effects for condition, pre-survey, grade, and the randomization block. This model indicated a statistically significant difference between the adjusted means of the treatment and control group post-test scores ($p < .01$) with an effect size of 0.507. On average, going from the control to the treatment condition results in a 0.4 increase in post-survey confidence subscale score (Exhibit 27).

Exhibit 27. Confidence Subscale Impact Model

Survey Scale	Estimates	SE	t-value	d.f.	p
(Intercept)	1.58	0.15	10.28	179.57	0.00
Treatment	0.40	0.08	5.18	18.36	0.00
pre	0.50	0.04	12.03	497.42	0.00
grade4	-0.36	0.22	-1.64	118.24	0.10
Cluster31	-0.08	0.11	-0.77	19.31	0.45
Cluster40	0.26	0.23	1.16	66.60	0.25
Cluster41	0.47	0.23	2.04	64.10	0.05

* Statistically significant result

The control group's mean rating decreased slightly from 3.26 to 3.20 whereas the treatment group's mean score increased from 3.37 to 3.60. In this model, the Treatment variable indicated that **the treatment group had a statistically significant higher post-test confidence rating** relative to the control group ($p < 0.05$) at an effect size of 0.605 (Exhibit 28).

Exhibit 28. Confidence Subscale Hedge's g Effect Size and Statistics

Condition	Mean	SD	n	Hedge's g	95% CI
Control	3.20	0.81	261	0.605	0.33, 0.68
Treatment	3.60	0.76	255		

Exhibit 29 displays the adjusted means of student post confidence subscale scores for both the control and treatment group.

Exhibit 29. Adjusted Means of Student Post-Confidence Subscale Scores
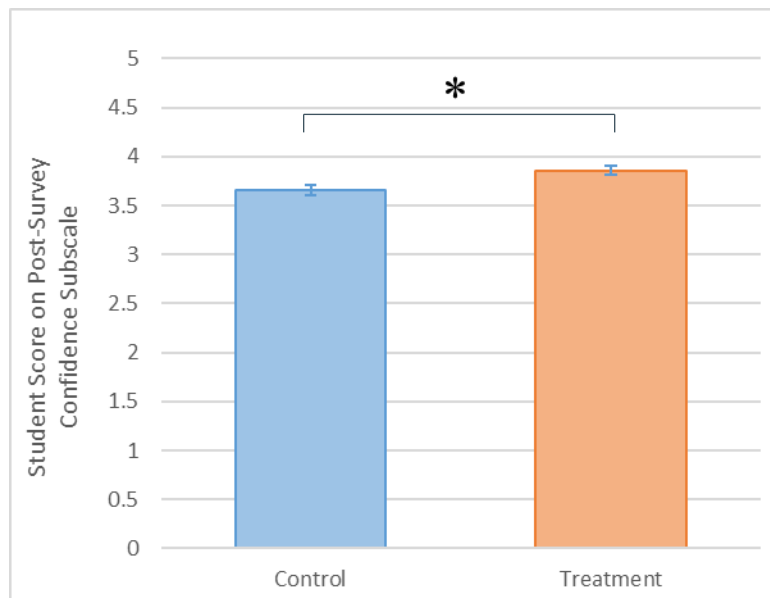
* p values calculated using Satterthwaite d.f.

Finding 3: MusiQuest seems to be more beneficial for students with lower self-reported confidence subscale scores

To further explore whether MusiQuest was differentially impactful for students with low confidence score and students with high confidence scores, we conducted a two-level hierarchical model including a random effect term to account for the nesting of students within teachers, the moderating variable pre-confidence subscale, the randomization

block, and an interaction term between the pre-confidence scale and the condition. In this model, students were divided into two groups based on their confidence subscale pre-scores: those below and those above the median.

The model revealed a statistically significant effect of the treatment and the pre-confidence subscale score on the post-confidence subscale score, which was moderated by the interaction between the two variables ($p < 0.05$). The result suggested the MusiQuest platform seems more impactful for students who come in with lower music confidence. Exhibit 30 shows the control and treatment group difference is larger among students with lower pre-confidence subscale scores (below median) than that in students with higher pre-confidence subscale score (above median). This indicates MusiQuest may offer additional benefits to students who lack confidence in their musical knowledge and abilities.

Exhibit 30. Confidence Subscale Score Interaction Effect
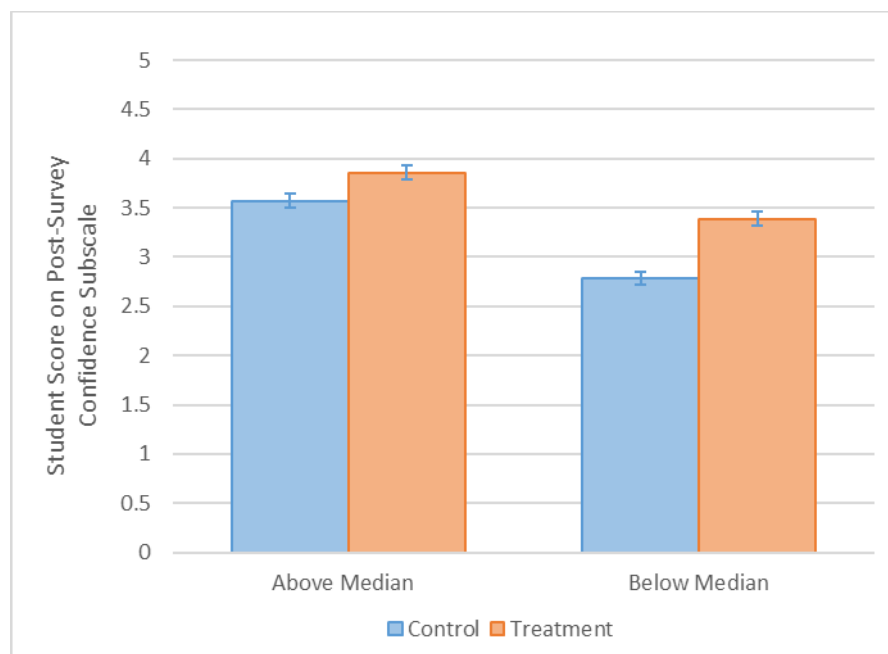
Finding 4: No difference existed in student self-reports of motivation

The analytic sample for the student motivation scale consisted of 514 students with 261 students from the control group and 253 students from the treatment group. There was no statistically significant difference between treatment and control students' self-reports of motivation.

We performed baseline equivalence testing to detect any differences in motivation scores between the control and treatment students at the start of the study. The baseline differences between groups on the pre-motivation scale was 0.13 standard deviations, which is considered within the range of statistical correction (Exhibit 31). This was accounted for in subsequent analyses.

Exhibit 31. Pre-Survey Motivation Subscale Baseline Equivalence

Condition	Mean	SD	n	Hedge's g
Control	4.01	0.78	261	0.13
Treatment	4.11	0.72	253	

We then assessed whether there were differences between the treatment and control groups using a two-level hierarchical model with a random effect to account for the nesting of students within teachers, and fixed effects for condition, pre-survey, grade, and randomization block. This model was not statistically significant (p = .38), indicating going from the control to the treatment condition did not result in a post-survey change in score on the motivation scale (Hedge's g = 0.09). Overall, there was no statistically significant difference between treatment and control students' self-reports of motivation.

Exhibit 32. Motivation Subscale Impact Model

Survey Scale	Estimates	SE	t-value	d.f.	p
(Intercept)	2.15	0.18	11.96	253.10	0.00
Treatment	0.07	0.08	0.89	19.77	0.38
pre	0.47	0.04	11.71	505.67	0.00
grade4	-0.15	0.22	-0.68	167.84	0.49
Cluster31	0.07	0.12	0.59	20.60	0.56
Cluster40	0.07	0.23	0.28	81.16	0.78
Cluster41	0.26	0.23	1.11	77.08	0.27

* p values calculated using Satterthwaite d.f.

The mean ratings for both the control and treatment groups remained similar between the pre- and post-surveys. The control group mean was 4.01 at pretest and 4.07 at posttest. Similarly, the treatment group mean was 4.11 at pretest and 4.14 at posttest (Exhibit 33). It should also be noted that student mean ratings for motivation were higher than the confidence and creativity scales at both pretest and posttest for the control and treatment students.

Exhibit 33. Motivation Subscale Hedge's g Effect Size and Statistics

Condition	Mean	SD	n	Hedge's g	95% CI
Control	4.07	0.79	261	0.09	-0.08, 0.26
Treatment	4.14	0.73	253		

Finding 5: No difference existed in student self-perceptions of creativity

The analytic sample for the student creativity scale consisted of 502 students with 255 control students and 247 treatment students.

Preliminary baseline equivalence testing was conducted to evaluate any differences in student creativity scores between the control and treatment groups prior to any exposure to the MusiQuest platform. The baseline differences between the groups on the pre-creativity scale was 0.08 standard deviations, which is considered within the range of statistical correction (Exhibit 34). This was accounted for in subsequent analyses.

Exhibit 34. Pre-Survey Creativity Subscale Baseline Equivalence

Condition	Mean	SD	n	Hedge's g
Control	3.82	0.62	255	0.08
Treatment	3.87	0.66	247	

We then assessed whether there were differences between the treatment and control groups using a two-level hierarchical model with a random effect to account for the nesting of students within teachers, and fixed effects for condition, pre-survey, grade and the randomization block. This model was not statistically significant (p = .20), indicating that going from the control to the treatment condition did not result in a significant post-survey change in score on the creativity scale (Hedge's g = 0.16). Overall, there was no statistically significant difference between treatment and control student self-report creativity (Exhibit 35).

Exhibit 35. Creativity Subscale Impact Model

Survey Scale	Estimates	SE	t-value	d.f.	p
(Intercept)	1.95	0.18	11.07	316.39	0.00
Treatment	0.11	0.08	1.33	21.80	0.20
pre	0.49	0.04	11.72	490.18	0.00
grade4	-0.26	0.20	-1.28	179.20	0.20
Cluster31	-0.04	0.11	-0.40	22.22	0.69
Cluster40	0.14	0.21	0.66	85.95	0.51
Cluster41	0.22	0.22	1.02	82.19	0.31

* Statistically significant result

Similar to the subscale for motivation, the scale for creativity showed student ratings remained relatively unchanged. The control group mean was 3.82 at pretest and 3.80 at posttest. Similarly, the treatment group mean was 3.87 at pretest and 3.90 at posttest (Exhibit 36).

Exhibit 36. Creativity Subscale Hedge's g Effect Size and Statistics

Condition	Mean	SD	n	Hedge's g	95% Confidence interval
Control	3.80	0.69	255	0.16	-0.01, 0.34
Treatment	3.90	0.67	247		

Finding 6: Small positive relationships were found between the average proportion of lessons completed and the student post-survey overall, post-confidence subscale, and post-motivation subscale scores

We also computed Pearson's product-moment correlations to explore whether there was any relationship between student use of MusiQuest and the student post-survey overall and its three subscales. The results showed small positive correlations between the average proportion of lessons completed and student post-survey ratings overall and on the confidence and motivation subscales (Exhibit 37). The correlations were not causal evidence; thus, further investigation is necessary to determine whether the usage itself was directly responsible for increased post-scores. However, these results suggest promising relationships between student use of MusiQuest and their attitudes toward music, as well as their confidence and motivation levels.

Exhibit 37. Correlation Coefficients for Proportion of Lessons Complete

| Survey Scale	Coefficient	p-value
Post-Survey Overall Score	0.192	0.002*
Post Confidence Subscale Score	0.170	0.007*
Post Motivation Subscale Score	0.224	0.0003*
Post Creativity Subscale Score	0.073	0.255

* Statistically significant result

Additional Findings

Finding 1: Teachers reported positive perceptions of MusiQuest

The majority of teachers had positive responses for all questions related to student attitudes toward MusiQuest. All teachers agreed or strongly agreed that MusiQuest positively impacted student attitudes toward music, with 71.4% strongly agreeing. All teachers agreed or strongly agreed that MusiQuest positively impacted student creative confidence, with 64% of teachers strongly agreeing. All teachers also agreed or strongly agreed that MusiQuest positively impacted student attitudes toward the arts, with 61.5% of teachers strongly agreeing. Over half of teachers agreed or strongly agreed that MusiQuest positively impacted student attitudes toward a career in the arts, with 45% of teachers strongly agreeing (Exhibit 38).

Exhibit 38. Teacher Perceptions of Student Attitudes
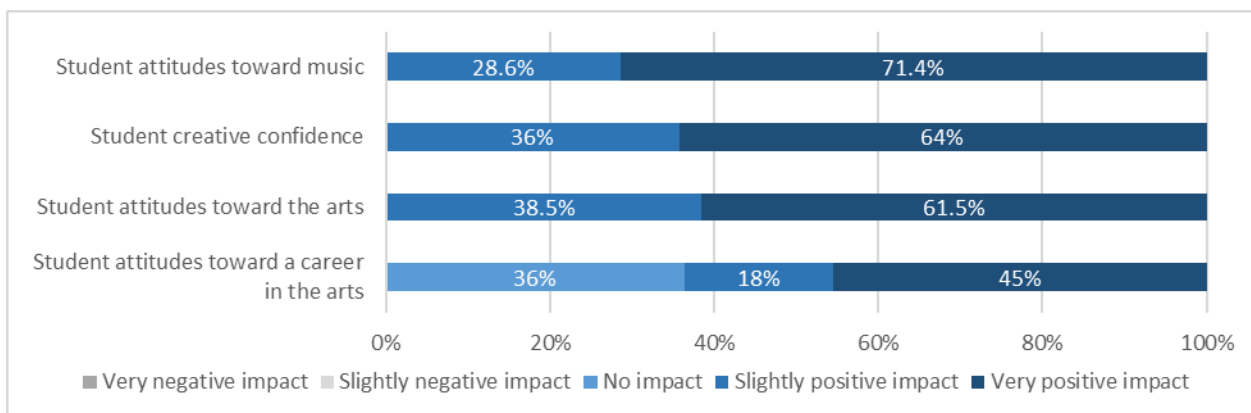
* Source: Teacher Post Survey

During teacher interviews, participants expressed that MusiQuest had a positive impact on students' feelings of self-efficacy regarding music and the arts. Students looked forward to and enjoyed using MusiQuest. Students liked that MusiQuest engaged them in the classroom in a unique way and allowed them to be collaborative. One teacher shared:

> *"They liked that they could embark on this journey on their own but also share what they made with their classmates."*

Several teachers said MusiQuest taught their students more than just music, offering important life lessons. Teachers agreed the most powerful lesson students learned was that there are no right or wrong answers in music or when being creative. This was highlighted by a teacher who commented:

> *"MusiQuest helped them learn to not be afraid to make mistakes."*

MusiQuest allowed students to be creative, to take ownership over something, and to express and explore the world in the classroom in ways many students had not been able to before. One teacher shared, "They got to create something that they had ownership over."

MusiQuest also increased student enthusiasm for music from around the world and increased the ways in which they could enjoy music. Teachers reported their students loved learning about music from other countries and MusiQuest encouraged students to be willing to try and explore other forms of music. One teacher commented, "Now their knowledge of music goes beyond Disney songs." Another teacher said,

> *"Recently I taught my students a new song, and they were more excited and more appreciative than before. They appreciate music more now. Without MusiQuest, it wasn't something they would have had."*

Some teachers did not notice an impact on student attitudes toward a career in the arts, but also admitted they had not asked their students if MusiQuest had an impact on their attitudes toward music, the arts, or a career in the arts. One teacher said the interview question was hard to answer, sharing:

> *"I think lots of them want to be famous, like Mr. Beast famous. I don't think they are able to make that correlation yet that they could pursue a career in the arts. I tried talking to my students about it; I told them they could go to college and study music."*

Finding 2: Teachers reports students who typically struggled in class gained self-confidence

Several teachers noticed their students' self-confidence improved from using MusiQuest, especially students who typically struggled in the classroom with reading and math. Students appeared more self-confident because they felt like they could be successful at music. MusiQuest allowed students who typically struggled with other academic subjects to feel good at something in school. Teachers noticed students who did not generally participate in class would participate more during MusiQuest class time and would be excited to share their musical creations. Students who normally did not show off would be proud of their musical creations and show off their MusiQuest pieces. This was highlighted by a teacher who explained:

> *"I have a student who struggles with all subjects. MusiQuest helped them feel like they were good at something. School is hard for them, but MusiQuest was something they were good at. So that helps with self-esteem and showing them that they are good at something."*

Student Engagement

Finding 1: Teachers reported high levels of overall student engagement

Teachers reported that students demonstrated high levels of excitement and interest while engaging with the MusiQuest platform. In the teacher post survey, 13 out of 14 teachers reported at least 80% of students in their classroom were engaged while using MusiQuest. One teacher observed,

> *"When everything ran smoothly, they very engaged, very excited, and looked forward to new lessons. A lot of it was, 'Did you assign a new lesson, when can we start, oh you should hear the song!' [One student] put headphones on me as the teacher so I could hear what she created... They got very excited."*
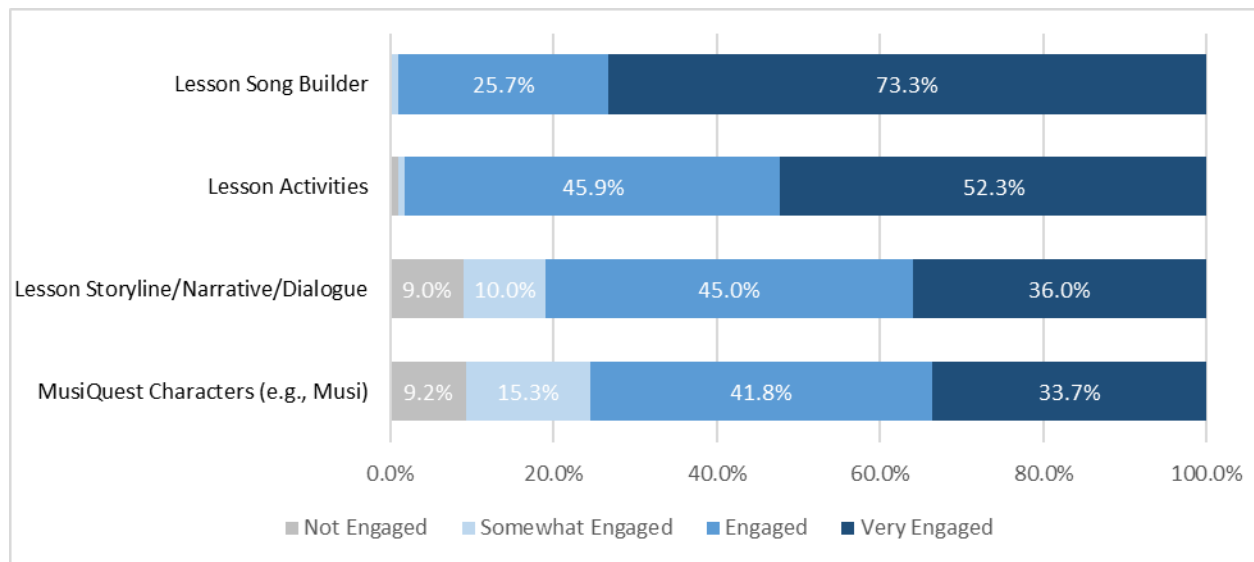
Multiple teachers noticed that students who would not typically share in class felt more comfortable sharing their experiences with MusiQuest compared to other topics. One teacher stated,

> *"The majority of the kids – even kids who don't like to talk – they would share out what they were doing [in a] whole class discussion."*

Another teacher reported discovering new personality traits among her students because MusiQuest allowed for self-expression not typically available in the classroom. One teacher shared, "I had students who forgot that they were in class and were just dancing to their music in their seats. I loved it."

Teachers additionally reported on student engagement for each MusiQuest component in their weekly logs. Exhibit 39 represents the aggregated data from the 13 teachers, covering lessons 1 through 9. Most teachers reported high levels of engagement across all components of MusiQuest; the Lesson Song Builder was the most engaging with 73.3% of teachers reporting this feature as very engaging. Half of the teachers reported the Lesson Activities as very engaging. About one-third of teachers reported the Lesson Storyline/Narrative/Dialogue and MusiQuest characters as very engaging.

## Exhibit 39. Student Engagement with MusiQuest Components

Lesson Song Builder: 25.7%, 73.3%
Lesson Activities: 45.9%, 52.3%
Lesson Storyline/Narrative/Dialogue: 9.0%, 10.0%, 45.0%, 36.0%
MusiQuest Characters (e.g., Musi): 9.2%, 15.3%, 41.8%, 33.7%

Legend: ■ Not Engaged ■ Somewhat Engaged ■ Engaged ■ Very Engaged

* Source: Lessons logs by 13 teachers from lesson 1 through 9.

Finding 2: Student survey response to MusiQuest were positive

Treatment student responses to questions about MusiQuest in the post-survey were positive. The student post-survey included questions asking for student opinions about their experiences completing the MusiQuest lessons. Figure 40 shows the majority of students had a positive response for all questions. Over 80% of students agreed or strongly agreed they enjoyed using MusiQuest in class and that MusiQuest helped them learn music. Nearly three-quarters of the students agreed or strongly agreed they wanted to use MusiQuest more, and over two-thirds of students agreed or strongly agreed MusiQuest helped them feel more confident in their music skills. Regarding the storyline, over half of the students agreed or strongly agreed the stories made the lessons easier to understand.

Exhibit 40. Student Attitudes toward MusiQuest
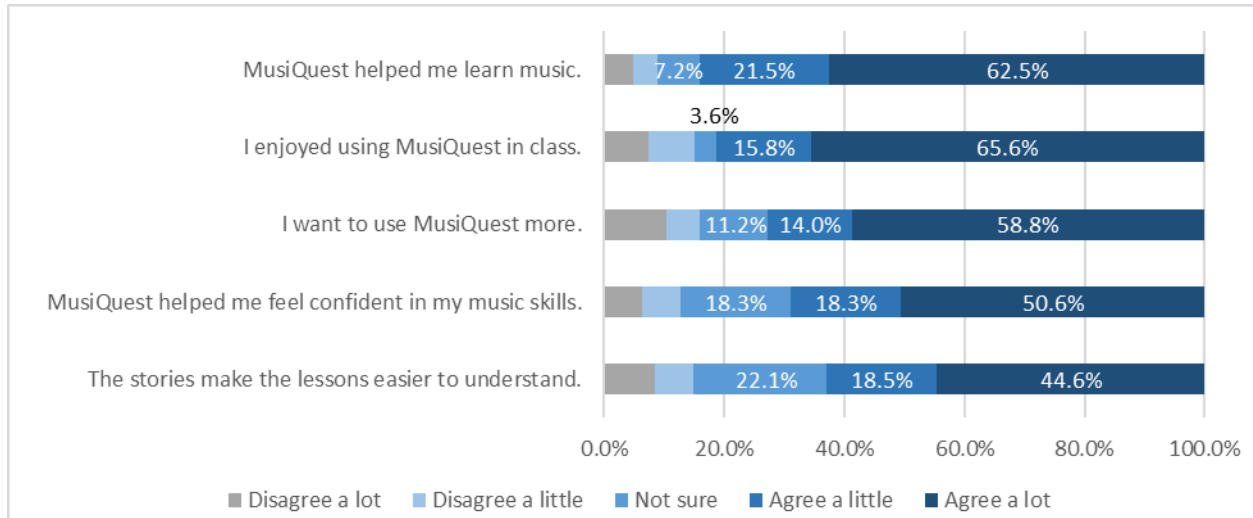
* Source: Student Post Survey

Finding 3: Students were highly engaged with the Song Builder features

Teachers observed that MusiQuest fostered an environment where students felt open to express themselves and contribute more readily. They attributed this to the platform's features, particularly the song builder, which allowed students to share without the pressure of finding a "correct" answer, thereby building their creative confidence. In the teacher logs, teachers reported students' overwhelmingly high engagement with the Song Builder (99.0%) and the lesson activities (98.2%). One teacher remarked,

> *"They aren't excited about division. They'll do it and I'll say great job. But to see them get excited about something they created and feel successful in it. Again, there was no wrong answer. So I did it. I created it. I think was probably the best part of the program."*

Another teacher echoed this sentiment, emphasizing the role of MusiQuest in providing students with a space for creative control and exploration, sharing,

> *"I think they were engaged with the fact that they were playing with sounds. It was something they were in control of. It was something where they were able to express their creativity. It was like their time to be creative, their time to play with music."*

Teachers observed high levels of student engagement with the song builder feature. According to one educator, students were "totally tuned in trying to make different pieces fit together," demonstrating their deep involvement. Throughout their interactions with MusiQuest, teachers consistently noted how students gravitated toward the song builder feature, spending significant amounts of time exploring its possibilities. The unanimous sentiment among teachers was that students showed a keen interest in this interactive tool. As one teacher expressed, "Students like to spend most of their time doing [the song builder]." Furthermore, teachers highlighted students' enthusiasm for specific aspects of the song builder, indicating their enjoyment of the interactive components. One teacher reported,

> *"They loved the drum one. When they were learning the drums. They loved when they could copy and paste. They liked the song builder."*

Alongside their engagement with the song builder, students also found satisfaction in the capstone element of their MusiQuest experience. They took pride in their musical creations and eagerly sought opportunities to share them with peers for constructive feedback. This was exemplified by teacher observations of students constantly wanting to have their music heard. One teacher shared how students were "constantly wanting to ask someone to listen to their music."

Finding 4: Students were less engaged with the lessons, especially the characters

Teachers observed a contrast in student engagement levels between the lesson portion and the song builder features of the MusiQuest platform. Despite students showing high levels of engagement with the song builder, their interest waned somewhat during the lessons. Teachers noted that students often felt disinterested and attempted to rush through the lessons to reach the song builder. One teacher recounted,

> *"Something else that came up a lot was that my students weren't interested in the characters at all. I would see my students [try to skip those parts] and I'd ask, 'what are you doing?' And they'd say, 'this part's boring.'"*

According to teacher logs, multiple educators expressed concerns about the duration of the lessons, wishing for a quicker transition to the song builder. As one teacher remarked, "There are too many guided lessons and not enough time to create their own music."

Another teacher speculated that the lower student engagement levels could be attributed to the lecture-focused nature of the lessons, lacking the interactivity students craved. This teacher remarked,

> *"Students were just not engaged with [the lessons]. Maybe they felt bored because it was just too explicitly teaching them? It was just – I don't know, they just weren't engaged with them at all, and because they weren't engaged with them at all, they weren't learning from them."*

Several teachers echoed similar sentiments regarding the perceived lack of engagement with the characters. One teacher reflected, "I'm not sure what part of that wasn't engaging to them, but we talked about it afterwards, and they said the characters were kind of boring."

One teacher highlighted how some students expressed frustration over their limited creative control during the lesson phase, stating, "Some of my students felt annoyed that the song they created would be deleted. The person on the screen would say 'I think this sounds better.' So, it didn't give them the flexibility." Another teacher noted the challenges faced by students with learning differences, observing, "Students who are special ed are struggling with completing the assignments, and become frustrated quickly."

Despite concerns about the length of the lessons and the perceived lack of engagement with the characters, teachers recognized the importance of delivering content. They acknowledged that students engaged with certain aspects of the lessons, particularly those exploring other cultures. As one teacher recounted,

> *"The students weren't always engaged with the story line. They said the characters talked too much, but I understand its value in teaching content. They really enjoyed the real-world musical examples. It was culturally relevant."*

Cost Analysis

Based on the estimates described in the Methods section (Appendix A), the total incremental cost of the intervention (i.e., the cost of the intervention subtracting out control group costs) was $9207.61 (Exhibit 41).

Dividing the total incremental cost amount by the number students in the intervention yields a per student cost of $34.88. Most of the incremental cost of the intervention was related to personnel costs. In this study, the cost of the student licenses was paid for by the developer.

This analysis indicated this intervention has a low overall incremental cost. This suggests the program is affordable and could be feasibly adopted by other schools. The importance of this analysis is underscored when considered alongside the intervention's impact estimates described above. Given these effects were achieved at minimal cost to interest holders, the impact results may be especially meaningful. For example, the intervention may be able to produce similar gains at minimal costs to future schools.

Exhibit 41: Cost Analysis Summary

Type	Ingredient	Price (per unit)	Edify		BAU		Total Incremental Cost (Present Study)
			Quantity	Total Cost	Quantity	Total Cost	
Personnel*	Teacher Training	$ 56.67	14 hours (14 Tx Ts *1 hr)	$ 793.39	0 $ -		$ 793.39
	Teacher Prep and Implementing MusiQuest	$ 56.67	140 hours (14 Tx Ts * 1 hr / wk * 10 wks)	$ 7,933.94	0 $ -		$ 7,933.94
Materials	Edify License	$ 5.00	264 students	$ 1,320.00	0 $ -		$ 1,320.00
Data & Tech	Chromebooks	$ 209.93	264 devices	$ 55,421.52	268 $ 56,261.24		$ (839.72)
			Total Cost: $ 65,468.85		Total Cost: $ 56,261.24		Total Cost: $ 9,207.61
			Student N: 264		Student N: 268		Student N: 264
			By Student: $ 247.99		By Student: $ 209.93		By Student: $ 34.88

*includes fringe benefit rates ~50%

Summary

The data from the classroom randomized control trial pilot study resulted in recommendations for improving the value of MusiQuest in upper elementary classrooms. These recommendations include:

MusiQuest Lessons

Consider shortening the lessons to 15-20 minutes and reducing the character dialogue and focusing on adding more visual and interactive features to the lessons. As noted, teachers and students felt the lessons were too long and less engaging than the song builder features. Integrating more interactive components requiring students to actively participate may retain student engagement for a longer duration. Consider incorporating components of the lesson requiring students to engage multiple senses. Perhaps the lessons could ask students to repeat vocabulary words aloud or follow a rhythm by tapping their fingers on their desk.

Consider adding a clear message indicating lesson completion to prevent confusion among students. Teachers observed that students frequently believed they had finished a lesson when there was still content remaining. To reduce this confusion, it is recommended to implement a completion bar at the bottom of the screen. Additionally, characters or app features could provide prompts encouraging students to continue and indicating their progress. Introducing a consistent final page appearing at the end of each lesson would also serve as a clear indicator of completion.

Consider incorporating music challenges and minigames where students can earn rewards or recognition for completing lessons. Some students recommended adding music challenges within the MusiQuest platform where they could receive digital prizes and coins from the minigames. A teacher recommended providing students with points for completing lessons. Consider incorporating minigames into the lesson to increase student engagement.

Student Accessibility

Consider incorporating features to support English learners, such as audio scripts that can be toggled based on reading ability and visual aids to accompany terminology. Teachers noted that English learners needed more visual cues and support navigating the lessons. One teacher suggested adding icons denoting components to support English learners and more scaffolds when students are confused and not progressing.

Student Accessibility

Consider incorporating features offering guidance when students encounter challenges while progressing through the lesson. Teachers observed numerous occasions where students felt confused about the necessary steps to advance in the lesson. One teacher recommended integrating a feature directing student attention to the specific areas they need to focus on after multiple unsuccessful attempts.

Consider adding an introductory video for students to set the context of the lessons. Some teachers felt students needed more background on the MusiQuest lessons prior to diving into the lesson content.

Teacher Resources

Consider providing teachers with resources incorporating music vocabulary terms to facilitate the introduction to MusiQuest lessons. Teachers shared that it would be helpful to have materials or even access to a brief presentation with music vocabulary definitions for teachers, including terms like intonation and melody. Teachers wanted to offer an introductory presentation to their students before each lesson, but many lacked the musical content knowledge to do so.

Consider providing teachers with more information about the storyline for each lesson within the teacher resources. Teachers also wanted to have more information beforehand about the storyline students were shown, noting it would be helpful to have access to a preview of the videos students would see with an option for a shorter or longer preview within the teacher lesson preview materials or within the teacher dashboard.

Consider providing teachers with resources for facilitating culturally responsive music education. Teachers requested resources to support them in facilitating culturally responsive conversations related to music, such as a guide to discuss being respectful of cultures and others' practices so teachers can better prepare their class.

Teacher Dashboard

Consider adding features to the dashboard to track student progress more specifically, allowing teachers to see where students are in each lesson. Multiple teachers expressed a desire to know more precisely where students were in the lessons, especially given student confusion about when the lessons concluded.

Consider developing a system to detect when students are stuck and signal to the teacher that more assistance may be needed so they can provide timely support. Some students were reluctant to ask for help so teachers were not aware they needed additional assistance.

Teacher Dashboard

Consider including a feature allowing teachers to pause all student activities for a class discussion to promote deeper learning. A teacher highlighted the challenge of refocusing students for whole-class discussions due to their deep immersion in the platform. To address this, it would be beneficial to implement a feature allowing teachers to pause student activities on their screens. This mechanism would facilitate seamless transitions to class discussions, thereby enhancing student experiences, reinforcing connections made during lessons, and improving classroom management.

Technical and Usability

Consider streamlining the password entry process, potentially with an instructional video on how to sign in.

Consider introducing a "save progress" button so students do not have to restart lessons if they exit early or face technical issues.

Consider optimizing the program to be more resilient to slow internet connections, ensuring progress is saved more frequently.

Summary

The study presented compelling evidence that implementation of MusiQuest in treatment classrooms had a positive impact on student musical skills, knowledge, and confidence. Students utilizing the program achieved statistically significant higher post-assessment scores, with an average improvement of .30 standard deviations. A positive correlation was also found between lesson completion and assessment scores, indicating more exposure to MusiQuest led to better results. Observations from both teachers and researchers, alongside student and teacher surveys, indicated MusiQuest positively influences student attitudes toward music and their musical confidence, and has potential to positively impact overall academic confidence as well. Finally, teachers and students reported a high level of engagement with, and positive attitudes toward, MusiQuest.

Teachers reported overall successful implementation of MusiQuest in their classrooms, despite some technical challenges, acknowledging its potential value and feasibility. Despite these overarching positive outcomes, the study identified areas for improvement and suggested enhancements that could improve engagement and student outcomes. By addressing these recommendations, MusiQuest has the opportunity to further amplify its positive impact on music education.

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Appendices

Appendix A – Detailed Study Methodology

Research Questions

The three research questions for this pilot study were:

1. How is MusiQuest, along with its key components of the leveled music creation interface and differentiated exercises, implemented in 3rd and 4th grade classrooms? Is it used with fidelity?
2. Does use of MusiQuest impact elementary students' musical skills and knowledge?
3. Does use of MusiQuest impact elementary students' attitudes toward music, the arts, or a career in the arts?

Study Overview

WestEd recruited 38 public school elementary teachers from California and Maine to participate in the classroom randomized controlled trial (RCT) pilot study. Teachers were randomized into treatment and control groups based on grade level and whether their class participated in a music program at the school. Initially, 19 teachers were randomized into the treatment group and 19 were randomized into the control group. Five treatment and five control teachers dropped from the study due to time constraints and other reasons. A total of 28 teachers participated in the RCT study, with 14 in each condition. The teachers were provided with a training on how to use MusiQuest and study details. Edify staff conducted the MusiQuest training and provided teacher support of the application, when necessary. Teachers were asked to teach 10 MusiQuest lessons over a span of about 10 weeks. Teachers administered the student measures described below and completed the teacher measures. Participating teachers received up to $600 stipend for completing all study activities.

Measures

Student Pre- and Post-Assessments: Pre and post knowledge assessments were researcher-developed and based on the goals of the unit. The assessment measures were prior piloted during the feasibility phase of the study. Cronbach's alpha were 0.607 and 0.700 for pre- and post-assessments, respectively, which meets acceptable reliability boundaries based on What Works Clearinghouse standards (2022). Treatment teachers administered these assessments before implementing MusiQuest, then again upon completion of MusiQuest implementation. Control teachers administered these assessments to their students at the same window of time as the treatment teachers.

Pre- and Post-Surveys: This researcher-developed survey assessed student self-efficacy and attitudes toward music, self concept and motivation, and creativity related to music. The survey included items based on the AMC Student Survey of creativity (Catterall, 2004) and the Self-Efficacy for Musical Learning questionnaire (Ritchie & Williamon, 2011). The post-survey included questions related to MusiQuest engagement and perceived usefulness for learning music. The survey instrument was piloted during the feasibility phase of the study. Cronbach's alpha coefficients for the overall survey were considered good, with 0.737 for the pre-survey and 0.789 for the post-survey. However, Cronbach's alpha coefficients for the motivation and the creativity subscales were both below 0.6, suggesting that each subscale separately is not considered very reliable (Exhibit A1; Clearinghouse, W.W. 2022). Since Cronbach's alpha is sensitive to the length of the survey, the value of Cronbach's alpha might be reduced due to the short length of the subscales (each containing 5 to 6 items; Tavakol & Dennick, 2011).

Exhibit A1. Cronbach's Alpha Coefficient for Subscales

Subscale	Pre-Subscale Cronbach's Alpha	Post-Subscale Cronbach's Alpha
Confidence	0.578	0.678
Motivation	0.544	0.590
Creativity	0.481	0.513

As with the assessment, treatment teachers administered the pre-survey before beginning implementation of MusiQuest and again upon completion of MusiQuest

implementation. Control teachers administered these surveys to their students at the same window of time as the treatment teachers.

Teacher Logs: Treatment teachers completed one teacher log per MusiQuest lesson. The logs asked questions about how they incorporated MusiQuest into their classroom, perceptions of student learning and engagement, and their use of teacher tools. The log for the last lesson contained music teacher self-efficacy items or modified items from the Music Teacher Identity Scale (MTIS).

Observations: Researchers documented how teachers implemented MusiQuest, student engagement, and teacher and student interactions during the lesson through online observations (via Zoom video conferencing platform) of a MusiQuest lesson for a subset of four Treatment teachers.

Teacher Post-Interview: A subset of six treatment teachers were asked to participate in an interview covering all research questions after the final MusiQuest study lesson.

Teacher Surveys. At the end of implementation, teachers in the treatment group were asked to complete a survey of their MusiQuest use, music exposure during the study, and any observed impact on student learning and attitudes. Teachers in the control group were asked to complete a survey of their students' engagement with the arts and music, as well as general music exposure, during the study.

MusiQuest Student Usage Data: Edify provided MusiQuest usage data related to duration of use, platform quiz scores, lessons completed, and student progress through the lesson. As appropriate, these were included in the analyses.

Sample

Twenty-eight elementary school teachers and their students participated in the study from public elementary schools and charter schools in California and Maine. Fourteen treatment teachers and 14 control teachers participated in the RCT study. Participating teachers taught 3rd (5 treatment; 8 control) or 4th grade (8 treatment; 5 control). One control and one treatment teacher taught a combination 3/4 class; students from both grades were included in the study.

Within the treatment group, six teachers were from schools with music programs that met with students about once a week, five teachers were from schools that did not offer music programs, and three teachers were from schools with hybrid programs in which music programs were either optional, not all students participated, or they offered informal/sporadically scheduled musical activities. Within the control group, three teachers were from schools with music programs, eight teachers were from schools that

did not offer music programs, and three teachers were from schools with hybrid music programs. Parents/guardians were given the opportunity to opt the students out of the study and students were given the opportunity to assent to the study. Teacher and school characteristics are summarized in Exhibit A2.

Exhibit A2. Teacher and School Characteristics

Characteristic	Control	Treatment
Number of teachers	14 teachers	14 teachers
Number of teachers from schools with a music program	Yes: 3 teachers No: 8 teachers Hybrid: 3 teachers	Yes: 6 teachers No: 5 teachers Hybrid: 3 teachers
Grade level in 2023/24 school year	3rd grade: 8 teachers 3rd and 4th grade: 1 teacher 4th grade: 5 teachers	3rd grade: 5 teachers 3rd and 4th grade: 1 teacher 4th grade: 8 teachers
1 student : 1 device ratio – Each student has access to their own device	14 teachers	14 teachers
Teacher plays an instrument or has other musical skills/knowledge	No experience: 4 teachers A little experience: 5 teachers Moderate experience: 1 teacher A lot of experience: 4 teachers	No experience: 3 teachers A little experience: 4 teachers Moderate experience: 2 teachers A lot of experience: 4 teachers
Teacher experience teaching music	No: 12 teachers Yes: 2 teachers	No: 11 teachers Yes: 3 teachers

*Source: Teacher Intake Forms

The study included teachers from 19 schools with a wide spectrum of socioeconomic statuses. Specifically, the school percentage of students eligible for free or reduced-price lunch (FRPL) varied significantly, from 8.4% to 97%. Within this group, three schools had an FRPL eligibility rate below 25.0%, signaling lower poverty levels, while nine schools had an FRPL eligibility rate between 25.1% and 50.0%, indicating mid-low poverty status. The remaining seven schools had more than half of their student population eligible for FRPL, reflecting high poverty conditions. Exhibit A3 provides a detailed snapshot of the FRPL percentages across the 19 schools, sorted from low to high percentage of students eligible for FRPL.

Exhibit A3. School Free or Reduced-Price Lunch Status

School	Number of teachers	Number of students	Percentage of students eligible for FRPL
School J	1	26	8.4%
School N	1	22	21.4%
School I	1	30	22.7%
School G	1	25	27.9%
School O	2	41	34.2%
School M	1	15	35.3%
School L	2	45	36.5%
School B	2	41	38.2%
School H	1	17	41.3%
School E	1	11	42.6%
School D	1	17	44.0%
School C	1	18	47.9%
School K	1	17	53.5%
School Q	1	17	62.1%
School R	2	19	70.0%
School P	1	28	71.9%

School F	2	33	76.6%
School A	2	37	86.0%
School S	4	73	97.0%
Total	28	532	

*Data sources: California Department of Education DataQuest Free & Reduced Price Meals Report 2023-24 and Maine Department of Education Percentage Free and Reduced School Lunch Report for Fiscal Year 2024.
**This table only reports the number of students and teachers included in the analytic sample of the study.

A total of 532 students were included in the analytic sample. These were students who did not drop, gave their assent, and had at least one set of pre-post survey or assessment scores to be included in the analysis. Exhibit A4 indicates student music experience entering the study. About half of participating students (51.6%) reported previously taking a music or band class in or outside of school, 34.8% of students reported no prior music class, and 13.6% were unsure. Nearly half of students (49.6%) reporting playing a musical instrument, 37.5% did not play an instrument, and 12.9% were unsure. When asked about whether they have previously sung in a choir, 29.2% indicated they had, about half of students (53.4%) had not, and 17.4% were unsure.

Exhibit A4. Student Musical Background (n=532)
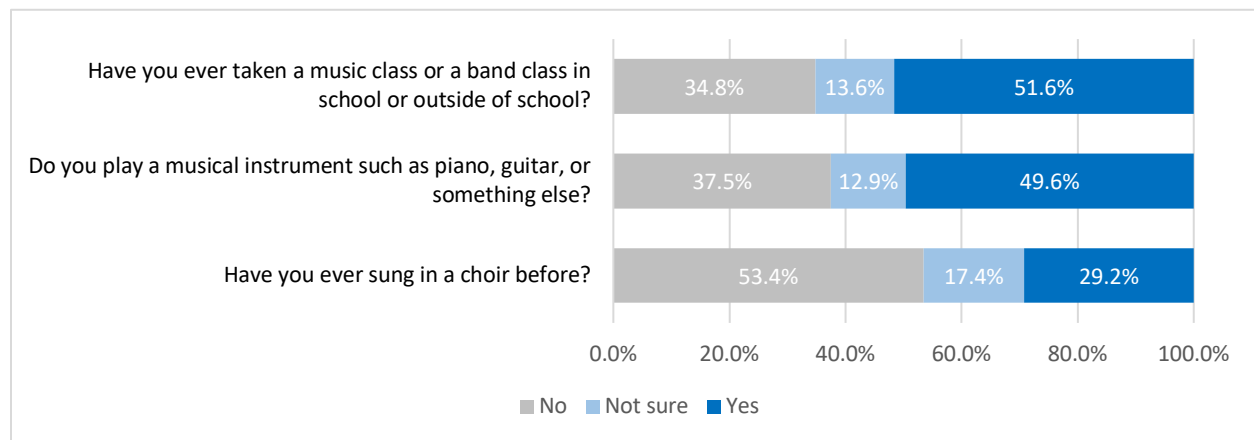
Quantitative Data Analysis Procedures

Attrition

Attrition was low for all outcomes. Attrition analysis was conducted both for the cluster level (classes) and the subcluster level (students). Attrition at the student level could occur due to missing pre- or post-test data, not providing consent, or dropping from the study. Students of teachers who dropped were not included in the attrition analysis. Based on attrition guidance from the What Works Clearinghouse, the study is considered low attrition when taking into account both the class-level and the student-level attrition[1]. Exhibit A5 presents the attrition data.

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[1] What Works Clearinghouse. (2022). *What Works Clearinghouse procedures and standards handbook, version 5.0*. U.S. Department of Education, Institute of Education Sciences, National Center for Education Evaluation and Regional Assistance (NCEE). This report is available on the What Works Clearinghouse website at https://ies.ed.gov/ncee/wwc/Handbooks.

Exhibit A5. Attrition Rate

		Overall Attrition	Treatment Group Attrition	Control Group Attrition	Differential Attrition	Attrition based on WWC's Cautious Criteria
Assessment	Class level	26.3%	26.3%	26.3%	0%	Low
	Student level	26.5%	28.5%	24.6%	3.9%	
Survey Overall	Class level	26.3%	26.3%	26.3%	0%	Low
	Student level	22.6%	22.7%	22.5%	0.2%	
Survey Subscale – Student Confidence	Class level	26.3%	26.3%	26.3%	0%	Low
	Student level	22.8%	22.7%	22.8%	0.1%	
Survey Subscale – Student Motivation	Class level	26.3%	26.3%	26.3%	0%	Low
	Student level	23.1%	23.3%	22.8%	0.5%	
Survey Subscale – Student Creativity	Class level	26.3%	26.3%	26.3%	0%	Low
	Student level	24.9%	25.2%	24.6%	0.6%	

*Differential attrition is the difference between treatment group and control group attrition.
***Attrition** based on WWC's Cautious Criteria*.

Data Analysis Procedure

For the quantitative analysis, student pre- and post-assessment and survey scores were graphed and summarized descriptively.

To statistically examine student gains, we conducted hierarchical linear modeling (HLM) to account for the nested structure of the design (e.g. students within classes). Only

students and teachers with complete data on variables used in the models were included in this analysis (defined as the analytic sample). In each model, post scores served as the outcome, and the experimental condition (treatment or control) served as a predictor. Other fixed effect predictors were included to control for participant characteristics that might be correlated with outcome, including pre-score (variable pre), grade (variable grade4), and randomization block (variables cluster31, cluster40, cluster41).

To further explore the moderator effects, whether MusiQuest is more impactful for different student subgroups, we conducted two-level hierarchical models that included a random effect term to account for the nesting of students within teachers, the moderating variables of interests (pre-score, gender, student music experience, and grade level), and an interaction term between each of the moderating variables and the condition. These moderator analyses were conducted for each student outcome. In this report, we only present the moderating model with statistically significant results.

Cost Analysis

The cost analysis was conducted using the ingredients method (Belfield, 2018). We included costs regardless of how they were funded. Personnel ingredients included teacher training, and teacher preparation and MusiQuest implementation time. Material ingredients included MusiQuest license fees and data and technology ingredients included the cost of Chromebooks. Ingredients common to both groups were the cost of the Chromebook used in the study.

All personnel costs incorporated a 53.7% fringe benefit rate and were based on 2020 national average salaries for public elementary and middle school teachers from the CostOut database (Hollands et. al 2015), as generalizable to a national context. Teachers implemented over 10 weeks and the average amount of time teachers indicated they spent to prepare lessons and teach in the class for each lesson was approximated to be 1 hour. We calculated these amounts by the number of implementation weeks (10), the number of treatment teachers (14), and the salaries to arrive at the teacher personnel costs. Further, we included 1 hour of teacher time to account for time spent attending an initial virtual training with the developer (multiplied by 14 teachers and their hourly rate.)

Chromebooks, estimated to be priced at $209.93 each from a major online retailer, were required for participation and thus mandatory costs for both treatment and control groups. Finally, we included a $5 subscription fee for each treatment student (the approximated rate for a MusiQuest license, as available publicly online). However, we note these costs were paid for by the grant funding or developer in the present study and therefore were not costs to the schools in this sample.