Exploring the Relationship Between Classroom Noise Levels and Student Learning: A Pilot Study with an Engineered Intervention

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Abstract

Noise levels in elementary classrooms can influence student learning and teacher experiences. Excessive noise can lead to reduced focus, increased off-task behavior, and lower academic accomplishments, especially for students in early elementary grades when attention and language development are most critical. While teachers often rely on classroom management strategies to maintain a positive learning environment, technological solutions have the potential to provide real-time feedback and positively influence student behavior. This paper explores the relationship between classroom noise levels and learning outcomes in Kindergarten through Fifth Grade settings, and evaluates an engineered device designed to encourage quieter classrooms.

A literature review was conducted to examine correlations between noise levels and student behavior and learning outcomes. Findings from prior research indicate that higher classroom noise levels are associated with increased behavioral disruptions and lower academic achievement. These findings highlight the need for simple, effective interventions that support teachers in maintaining a quieter, more focused learning environment.

To address this need, a device was designed and developed that monitors classroom sound levels and provides real-time feedback to students. The device gives multiple opportunities for students to maintain a quieter environment. Teachers can use the device as part of a positive reinforcement strategy, providing incentives such as extra recess or special activities if the class maintains an acceptable noise level for a set period of time.

The device was tested in elementary classrooms over the course of one week. Teachers completed surveys evaluating their experiences with the device. Teacher surveys asked: (1) to what extent the device made the classroom quieter, (2) whether it improved the learning environment, and (3) how user-friendly it was, each on a 0–6 scale. Open-ended feedback was also collected for suggested improvements.

This study aims to answer three primary research questions: (1) What is the relationship between noise level and student learning and experience? (2) Does the engineered device effectively reduce classroom noise? (3) Does the device improve the learning environment? Preliminary findings suggest that simple, student-centered engineering interventions may effectively support teachers in maintaining quieter, more productive classrooms. This work demonstrates the potential of integrating engineering solutions into classroom management practices, creating environments that better support young learners.

Introduction

Noise is a part of the elementary classroom environment. However, excessive noise can interfere with both teaching and learning. In elementary grades students are still developing critical skills such as attention control, language comprehension, and self-regulation. During this formative time, classroom conditions play an important role in shaping learning. When sound levels exceed certain thresholds, distraction occurs and instruction is disrupted, student focus is reduced, and off-task or disruptive behaviors are increased. This ultimately hinders academic progress.

Teachers often rely on classroom management strategies, verbal reminders, and behavioral systems to regulate noise and work to provide a productive learning atmosphere. While these methods can yield desired results, they often require constant monitoring and intervention. This places additional demands on teachers' time and attention. As classrooms become increasingly dynamic and student-centered, there is a growing need for tools that support teachers in managing learning environments with minimal additional needs from the teacher.

Recent research has shown a clear relationship between elevated classroom noise levels and negative impacts on student behavior and academic performance. These findings suggest that maintaining appropriate noise levels goes beyond a matter of discipline. It is an essential component of effective learning environments. And thus, there remains a need for basic interventions that can be easily integrated into everyday classroom routines.

This study examines the impact of classroom noise levels on student learning and teacher experience in early elementary extracurricular classrooms and evaluates an engineered device designed to provide real-time feedback on sound levels. By encouraging student awareness and accountability through immediate feedback and positive reinforcement, this device aims to reduce excessive noise and promote a calmer, more focused classroom environment. Through a review of existing literature and classroom testing, this research explores engineering-based solutions as possible tools for improving learning conditions for young students and supporting teachers in their classroom management efforts. Note, in this study, the term sound is used to describe objectively measurable acoustic energy within the classroom environment, whereas noise refers to sound that is perceived as unwanted or disruptive and that interferes with students' cognitive processing and learning tasks.

Background

Classroom Noise and Its Impact on Learning

Classroom noise has been consistently shown to negatively affect students' cognitive and academic performance, including particularly strong effects observed among children of ages 6 to 12 years old. Multiple studies give results that younger students are more vulnerable to noise-related disruptions than older students and adults [1, 2]. These heightened impacts are especially concerning because children in this age range are still developing executive functions, thus making it more difficult for them to filter out unnecessary sounds and maintain attention in noisy environments [1].

Studies show that classroom noise adversely affects many learning-related outcomes. Reading fluency has been shown to decline under noisy conditions [3, 1], while reading speed decreases as speech-noise intensity increases [2]. Noisy environments have also been associated with reduced nonword repetition accuracy and increased verbal processing time, thus interfering with both accuracy and efficiency of language processing [4, 1]. Multiple studies showed children aged 6 to 12 consistently exhibited significantly poorer performance in noisy environments compared to quieter conditions, thus reinforcing concerns about classroom noise levels and younger learners [1].

In addition to literacy-related outcomes, classroom noise has been shown to negatively affect mathematical performance, an important component of STEM learning. When investigating noise effects on students' math performance, a detrimental effect of classroom noise on accuracy was observed for the youngest students in the study, indicating that younger learners are particularly susceptible to noise-related disruptions during mathematical problem solving [5]. These findings suggest that noise not only interferes with language-based tasks but also with the cognitive processes required for numerical reasoning and sustained attention.

Both speech-based noise (e.g., classroom babble) and non-speech noise (e.g., traffic or aircraft) have been shown to impair children's academic performance. However, speech noise appears to have a stronger effect [2]. Performance across a range of tasks—including memory, attention, motivation, reading, and spelling—have been found to be lower under babble noise conditions when compared to quiet settings [6, 2]. Noise levels significantly influenced verbal task performance, with students performing worse in babble conditions than in baseline environments [6]. Importantly, emerging evidence indicates that elevated non-speech noise levels in classrooms are also associated with lower mathematics achievement, extending the impact of noise beyond language-based domains and into quantitative learning [7]. Additionally, children with special educational needs were found to be more affected by babble noise than their peers, thus indicating that noise exacerbates existing learning challenges [6].

These findings align with broader conclusions that children require quieter learning environments than adults for effective decoding and processing of oral information [8]. Students' subjective experience of noise also plays a role, as researchers have found that the more students reported being bothered by noise, the lower their math scores, highlighting the interaction between sound conditions, student perception, and academic performance [9].

Observational studies further show that many classrooms exceed recommended noise levels, compounding the risk of a loss of learning [10]. Collectively, research demonstrates the importance of lowering classroom noise to support student concentration, cognitive processing, and academic performance, especially for younger learners [1].

Behavioral Interventions to Reduce Classroom Noise

In response to the negative effects of classroom noise, researchers and educators both have explored behavioral interventions, aimed at reducing disruptive behaviors that can contribute to excessive noise levels. One of the most extensively studied interventions is the Good Behavior Game (GBG), first introduced by Barrish, Saunders, and Wolf to reduce disruptive behaviors in elementary school classrooms [11, 12]. GBG is a classroom management strategy designed to increase self-regulation, group regulation, and prosocial behavior, with the overarching goal of reducing problematic behaviors that interfere with instruction [13].

In its original implementation, the classroom was divided into teams, and students were expected to engage appropriately in academic activities such as math or reading. Desired behaviors, such as paying attention and participating in lessons, were reinforced, while behaviors that disrupted instructions such as leaving one's seat or interrupting—resulted in penalty points for the team. This was designed to be similar to a competitive game structure [13]. This interdependent group contingency encourages collective or 'whole class' responsibility for maintaining appropriate classroom sound levels.

Several studies provide evidence that the GBG effectively reduces disruptive behaviors and promotes 'good' behaviors in the general student population, qualitative findings suggest that teachers may find it more difficult to engage students with disruptive or socially withdrawn behaviors, and that behavior change may take longer for students with learning or behavioral difficulties [14]. Additionally, a potential drawback of the GBG is that individual students may be blamed by peers for team losses. This could potentially lead to negative peer pressure for students who consistently struggle to follow classroom rules [14].

Beyond the GBG, additional behavioral interventions have been explored. Studies examining classroom management mobile applications report mixed results regarding their effectiveness in producing sustained behavior change [15]. Another approach, the Quiet Classroom Game, employs an interdependent group contingency using an iPad equipped with a decibel meter [16]. Group contingencies such as this offer a practical means of administering a single consequence to influence the behavior of an entire class [16]. Results from studies of the Quiet Classroom Game indicate that implementation of the intervention can lead to quick reductions in off-task behavior [16], which suggests hope for behavior-based strategies that directly target classroom noise levels.

Taken together, these findings suggest that classroom noise not only disrupts language-based learning but also undermines the attention, working memory, and accuracy required for mathematical reasoning and broader STEM learning, reinforcing the need for effective noise-mitigation strategies in classrooms where early STEM skills are developed. While behavioral interventions such as the Good Behavior Game and the Quiet Classroom Game show promise in reducing disruptive behaviors that contribute to classroom noise, challenges remain regarding inclusivity, implementation feasibility, and sustained effectiveness across diverse student populations. These gaps highlight the need for continued investigation into practical strategies for reducing classroom noise and supporting student learning. The present study builds on this body of work by examining effectiveness of a noise demonstration and performance device, with particular attention to young students in learning environments, as described in the following methods section.

Research Questions

The research questions investigated in this study are: (1) What is the relationship between noise level and student learning and experience? (2) Does the engineered device effectively reduce classroom noise? (3) Does the device improve the learning environment?

Methods

Image 1

Study Design and Intervention

This study investigated an engineering-based behavioral intervention to reduce excessive noise levels in early elementary classrooms and improve the overall learning environment. The primary intervention was an engineered sound-level monitoring device designed to support student self-regulation through real-time feedback. The Quiet Classroom device (patent-pending and shown to the left in Image 1) continuously measures ambient sound levels and compares them to a teacher-defined noise threshold, which is selected based on classroom expectations and the type of instructional activity occurring.

At the beginning of each part of class, the teacher sets a threshold based on the planned activities. When classroom noise exceeds the preset threshold for a sustained duration, the device automatically removes one strike then sets a delay so that the class is given time to quiet down. The remaining strikes are visibly displayed. This allows students to monitor their collective behavior in real time. If the class maintains acceptable sound levels and retains at least one strike by the end of the designated part of class, students earn a teacher-selected reward, for example an additional recess time or a special classroom activity. The intervention is intentionally framed as a positive reinforcement strategy rather than a punitive system.

Participants and Implementation Context

The Quiet Classroom device was implemented in Kindergarten through Fifth Grade classrooms in an extracurricular learning setting over a one-week trial period. Participating teachers integrated the device into their normal classroom routines without altering content or class schedules. Students were informed about how the device functioned, with an emphasis on their shared responsibility and self-regulation to support a productive learning environment.

Data Collection Instrument

To evaluate the effectiveness and usability of the intervention, participating teachers completed a post-use questionnaire following the one-week implementation period. The questionnaire consisted of three sections assessing (1) classroom environment and device impact, (2) usability and function, and (3) overall experience.

Quantitative items used Likert-type scales ranging from 0 to 6 to assess teachers' perceived changes in classroom noise levels, learning environment quality, student engagement or focus, and device user-friendliness. Additional multiple-choice items evaluated ease of setup and operation, as well as student understanding of the device and the behaviors it promoted.

Qualitative data were collected through open-ended questions that invited teachers to describe observed changes in student behavior, reflect on both teacher and student experiences, and provide suggestions for device improvement. This mixed-methods approach allowed for both numerical assessment of perceived impact and deeper insights into classroom implementation.

Ethical Considerations

This study was conducted in accordance with institutional and ethical guidelines for research involving human participants. The study protocol, including data collection procedures and the teacher questionnaire, was reviewed and approved by the Institutional Review Board (IRB) at the University of Colorado Boulder, IRB Number 25-0711. Participation was voluntary, and all teacher responses were collected anonymously. No student-identifying data was collected as part of this study.

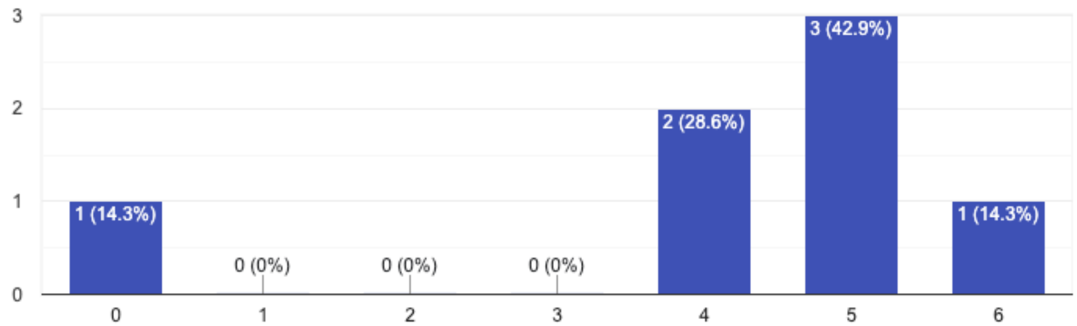
Results

Student behavior showed significant positive changes during the study. The strike system encouraged students to monitor their own volume and remind their peers when noise levels were too high. Teachers noted that students became more self-regulated, responded quickly to the device's feedback, and were proactive in maintaining an appropriate noise level. Engagement and focus ratings also increased over the duration of the trial, indicating that students were paying more attention during lessons and independent activities as noise decreased.

The survey was taken January through April 2026. Seven teachers precipitated in the survey. The results are shared below.

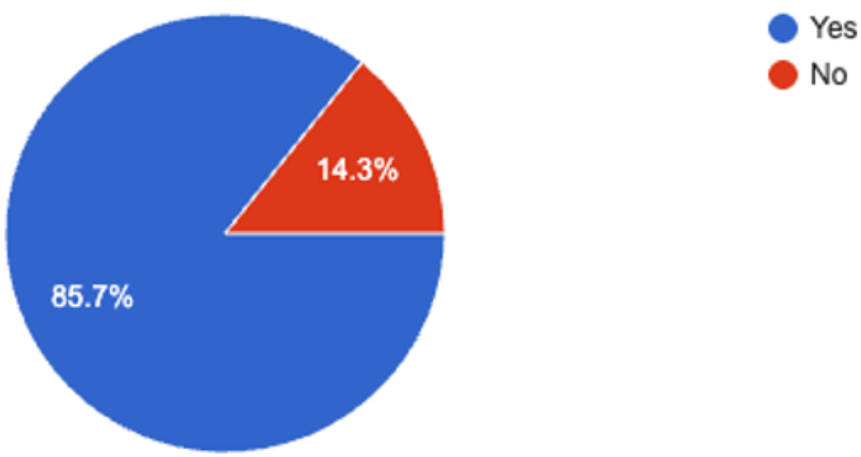
On the survey, the first question asked was, 'On a scale of 0-6 (0=no difference, 6 =extremely quieter), how much quieter did the device make your classroom?' In response to this question 86% of responses showed a positive result that the device decreased classroom noise level, as shown in Figure 1. Of these positive results, 14% selected 6 (extremely quieter), 43% selected 5 and 28% selected 4. One teacher (14%) selected 0 and noted that she had parents visiting the classroom during the class-time of testing and that it could not be distinguished if the noise reduction or behavior change was from the device or from the presence of parents in the classroom.

Figure 1: Responses to 'How much quieter did the device make your classroom?'



The second question asked, 'Did you notice changes in student behavior related to noise levels?' (Yes, No). In the response to this question, 86% responded yes, as shown in Figure 2.

Figure 2: Responses to 'Did you notice changes in student behavior related to noise levels?'

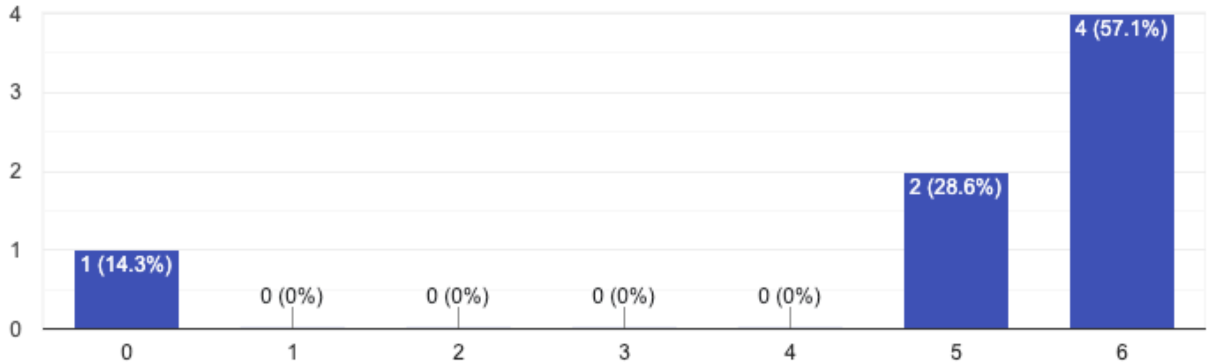


For those who responded 'yes', they were asked to explain. Some responses received include:

> "The students were interested in the device and how it worked. They also went quieter and quieter as the levels started to drop and started to pay attention to us teachers more."
>
> "Students wanted to be quieter and wanted the other students to be quieter. It shifted their focus and also their attitudes toward one for quiet and learning."

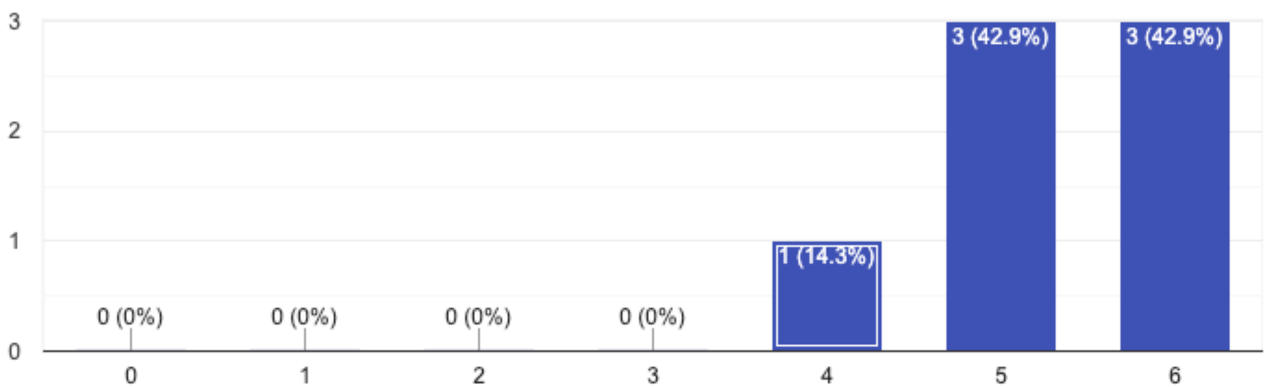
Teachers were then asked, 'On a scale of 0-6 (0=no impact, 6=strong positive impact), how much did the device seem to impact students' engagement or focus?' In response to this question, 57% of teachers selected 6, a strong positive impact, and 29% selected 5, and 14% selected 0. This data is shown in Figure 3.

Figure 3: Responses to ‘On a scale of 0–6, how much did the device seem to impact students’ engagement or focus?’



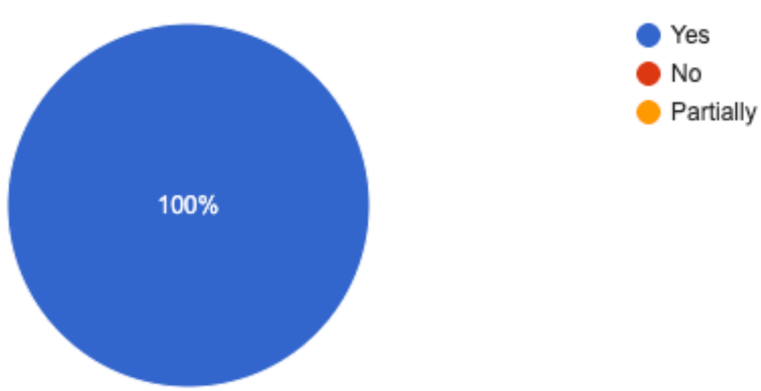
Subsequently, teachers were asked to rank on a scale of 0-6, ‘How user-friendly was the device?’ (0=not user-friendly, 6= very user-friendly) and 100% of the responses showed that the device was user-friendly, with 14% selecting 4, 43% selecting 5 and 43% selecting 6, very user-friendly. This is shown in Figure 4.

Figure 4: Responses to ‘On a scale of 0–6, how user-friendly was the device?’



Teachers were asked if the students understood how the device worked and what behavior it encouraged. 100% of the teachers responded with yes, as shown in Figure 5.

Figure 5: Responses to ‘Did students understand how the device worked and what behavior it encouraged?’



When asked, ‘What was your overall experience using the device?’, teachers’ responses included:

> “Great! I loved not having to use words to get the class’s attention, like "class, class". I no longer needed these sorts of things to gain control of class noise.”

> “We loved it because it was a good tool to get the students to quiet down and pay attention especially when they started to get distracted or chaotic.”

And when asked, ‘What was your perception of the students’ experience with the device?’, some of the teachers’ responses included:

> “They seemed to enjoy having it in the classroom. After the test class, they would ask where it was. They showed interest in the device returning to the classroom.”

> “The students loved it! They were really intrigued with the device, and it became a tool for positive reinforcement.”

> “I think they really liked being able to engage with the device and being able to see how loud is too loud.”

In summary, teachers consistently reported that the device was user-friendly and easy to incorporate into daily routines. Ratings for usability ranged from 4 to 6, and setup was generally described as “somewhat easy” to “very easy.” Students were able to understand the purpose and function of the device, and the visual strike system provided immediate feedback that reinforced positive behavior. The combination of visual transparency and immediate feedback contributed to both teacher and student satisfaction with the device. These results indicate that simple, engineered interventions like this device can meaningfully support classroom management and create a more productive learning environment for young students.

Conclusions

This study contributes to the growing body of evidence demonstrating that excessive classroom noise negatively affects students’ learning, attention, and academic performance, with particularly pronounced impacts for younger learners. Prior research has consistently shown that children between the ages of 6 and 12 are especially vulnerable to noise-related disruptions due to developing executive functions and limited ability to filter auditory distractions. These include literacy, verbal processing, mathematics and other STEM-related tasks, where noise has been associated with reduced accuracy, slower processing, and lower achievement. Taken together, the literature emphasizes the importance of creating learning environments that support favorable acoustic conditions, particularly in early elementary classrooms.

Building on this foundation, the present study explored an engineering-based, behavior-supportive intervention designed to help regulate classroom noise levels. Rather than relying solely on teacher correction, the sound-level monitoring device provided real-time, objective feedback that encouraged student self-regulation and collective responsibility. Teachers integrated the device into their existing classroom routines, framing it as a positive reinforcement tool that supported instruction. Post-use survey responses indicated that teachers perceived improvements in classroom noise levels, student engagement, and the overall learning environment, while also reporting that the device was generally user-friendly and easy to implement.

Importantly, this intervention highlights the potential role of engineering solutions in addressing educational challenges, including those that have traditionally been approached through behavioral or pedagogical strategies alone. By translating abstract expectations about “appropriate sound levels” into visible, measurable signals, the device helped bridge the gap between physical sound levels and students’ behavioral choices. This approach is relevant for STEM learning contexts, where sustained attention, problem-solving, and cognitive processing are critical. Reducing disruptive noise may therefore support not only classroom management but also students’ capacity to engage meaningfully with mathematics, science, and engineering tasks.

While the findings of this study are promising, they are limited by the short duration of implementation and reliance on teacher-reported outcomes. Future work could examine longer-term use of sound-monitoring interventions in a greater variety of classroom environments and further explore connections between noise reduction and student performance in specific academic domains, including math and STEM assessments. Nonetheless, this study demonstrates that thoughtfully designed, low-cost engineering interventions can play a valuable role in improving classroom environments and supporting equitable learning conditions for young students.

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Appendix A Questionnaire

Teacher Feedback Questionnaire: Classroom Noise-Monitoring Device

Thank you for participating in this study. Your feedback is essential to help us understand the effectiveness and usability of the classroom noise-monitoring device. This questionnaire should take approximately 10 minutes to complete.

Please respond based on your experience during the one-week trial period.

Section 1: Classroom Environment and Device Impact

1. On a scale of 0–6, how much quieter did the device make your classroom?
0 = No difference
6 = Extremely quieter
Response: ___

2. On a scale of 0–6, how much did the device improve the learning environment?
0 = No improvement
6 = Significant improvement
Response: ___

3. Did you notice changes in student behavior related to noise levels?

- ☐ Yes
- ☐ No
- If yes, please briefly describe:

4. On a scale of 0–6, how much did the device seem to impact students' engagement or focus?
0 = No impact
6 = Strong positive impact
Response: ___

Section 2: Usability and Function

5. On a scale of 0–6, how user-friendly was the device?
0 = Not user-friendly
6 = Very user-friendly
Response: ___

6. How easy or difficult was the device to set up and operate?

- ☐ Very easy

- ☐ Somewhat easy
- ☐ Neutral
- ☐ Somewhat difficult
- ☐ Very difficult
  Comments (optional):

7. Did students understand how the device worked and what behavior it encouraged?

- ☐ Yes
- ☐ No
- ☐ Partially
  If partially or no, please explain:

Section 3: Overall Experience

8. What was your overall experience using the device?
(Open-response)

9. What was your perception of the students’ experience with the device?
(Open-response)

10. What suggestions do you have for improving the device?
(Open-response)

11. If you could summarize your experience with the device in one sentence, what would it be?
(Open-response)

If you would like to be contacted about future studies or updates to this project, please indicate below:

- ☐ Yes, please contact me
- ☐ No, thank you