SOUNDing Off On Student Support
How much support do students need in order to construct understandings from inquiry science activities?

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Second Grade

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Contents

A. Description of Teaching Context

B. Wonderings and Sub-Wonderings

C. Data Collection and Analysis
   1. KLEW charts
   2. Student Interviews
   3. Scientific Notebooks
   4. Student Assessment
   5. Video Recordings
   6. Student Observations

D. Explanations and Findings
   1. Claim A: Students are best able to construct understandings from their observations when teacher questions are sequenced from narrow to broad.
   2. Claim B: There is a relationship between repeated exposure to lesson concepts and students’ abilities to make claims and conclusions based on evidence.
   3. Claim C: Students of varying academic abilities require different methods and levels of support from their teachers and peers.
   4. Claim D: All students benefit from multiple opportunities to engage in scientific discussion and collaboration with peers and teachers.

E. Reflection and Implication for Future Practice

F. References

G. Appendices
SOUNDing Off On Student Support

How much support do students need in order to construct understandings from inquiry science activities?

Description of Teaching Context

This inquiry project was conducted in two self-contained second grade classrooms, Room 11 and Room 40, at Radio Park Elementary School in State College, Pennsylvania. We are two PDS (Professional Development School) interns who are student teaching for a full year in the State College Area School District. The State College Area School District is a large district located in central Pennsylvania. The district includes one high school, two middle schools, and ten elementary schools, totaling approximately 7,200 students during the 2007-2008 school year.

In Room 11, there are 10 girls and 12 boys. There are two African American students, and three students who receive ESL services with Chilean, Kuwaiti, and Saudi Arabian backgrounds. One student is of Asian descent, and the remainder of the students are Caucasian. The learning and emotional needs of the students in this classroom are quite varied, including three students who receive Title 1 services, four students who attend learning support, three students who attend learning enrichment, two students who receive occupational therapy for writing, and two students who are currently undergoing IST evaluations. The desks in this classroom are arranged in groups, which promote open communication and facilitate effective group work.

In Room 40, there are seven girls and 14 boys. There are two African American students, one Asian student, one student of Asian and American heritage, and one Middle Eastern student. The remainder of the students are Caucasian. The educational needs of the students in Room 40 are wide-ranging as well. Four students receive reading assistance through the Title 1 program, and one student requires occupational therapy to assist his writing/small motor skills. There are
several students obtaining learning enrichment, and two students who attend learning support. The desks in the classroom are arranged into five clusters, and similarly to Room 11, open communication and positive student collaboration are encouraged and fostered.

**Wonderings and Sub-Wonderings**

**Main Wondering:**
How does the amount and method of support during science lessons affect students' abilities to translate observations and experiences into scientific explanations?

**Sub-Wonderings:**
- What kind of teacher questioning (broad or specific) do students need in order to construct explanations from their observations?
- How does repeated exposure to a certain content area influence student understanding and their ability to connect observations to learnings?
- What levels and methods of support do students of varying academic ability need in order to connect observations to learnings?
- How does verbal support from others (students and teachers) impact student learning?

**Data Collection and Analysis**

We used multiple methods of data collection in order to analyze the student learning occurring in our classrooms. Also, due to the wide range of student ability levels, our varied approaches to data collection allowed for the most valid and appropriate gauge of student understandings. In addition to these methods of data collection, we were in constant communication with one another to compare results and observations across classrooms.
1. **KLEW Chart (Appendix B)**

In each of our classrooms, we implemented a KLEW chart. As we began our science unit, the KLEW chart allowed us to pre-assess our students’ knowledge as they recorded what they thought they knew about sound, as well as their wonderings. Throughout the duration of our science lessons, we utilized these charts often. During our science talks at the completion of each lesson, students recorded what they had learned as well as the evidence they had collected to support these learnings. The KLEW charts provided concrete, written examples of students’ abilities to connect their learnings with the evidence they had collected. In order to analyze the KLEW charts, we took the completed charts from Room 11 and Room 40 and looked at the Learnings and Evidence columns on the two charts. We looked at each piece of information in the L column and recorded whether or not the students were able to provide support for this learning in the E column. We also looked for occurrences of substantial support (more than one piece of evidence to support a learning). We compared these data with the dates on which each lesson was taught. We used this information to note any patterns or changes in students’ ability to connect their learnings with evidence over time.

2. **Student Interviews (Appendix C)**

We interviewed the students in our classrooms in order to gain further insight into the students’ opinions and preferences about methods of science instruction and support. Interview questions allowed students to rate the helpfulness of science activities on a scale of one through four (four being the most helpful in regard to facilitating student understanding). Anecdotal notes were taken to record students’ verbal responses to each question. Interview questions pertained to KLEW charts, science talks, scientific notebooks, structure of teacher questioning, and collaboration with peers. After collecting students’ interviews, we charted students’ responses.
We then charted and grouped similar student responses for each question and identified patterns within the responses and ratings. When analyzing the item “Which type of question was easier for you to answer- broad or specific?” we first grouped the interviews into three different piles. One pile contained students that found broad questions easier to answer, the next pile contained students that felt that specific questions were easier to answer, and the third pile contained a student who answered, “it depends on the question and what we are learning about”. Once we reviewed these piles and noted our data, we continued to group the interviews into different piles, depending on students’ reasonings. We grouped students together who stated that they found specific questions easier because they understood what the teacher was asking. We made a different pile for students who preferred to answer specific questions because they could think about the experiments that they performed and knew how to answer the question. Once this process was completed we were able to observe patterns in our data. We followed a similar pattern when analyzing all questions.

3. Scientific Notebooks (Appendix D)

Students brought their notebooks with them as they participated in hands-on scientific experiments and used them to record observations, organize discoveries and construct scientific explanations from observations. Scientific notebooks were also used as a tool for teachers to gauge what type of questioning students were the most comfortable with and capable of answering, as well as how students were progressing as the unit continued. Students had the opportunity to record their observations in multiple ways, and some students’ worksheets were differentiated in order to set all students up for success in science. After each lesson, we reviewed students’ notebooks and discussed students’ abilities to successfully answer the various methods of questioning. As we began to analyze students’ notebooks, we separated the
worksheets according to concept. We were then able to look for and chart students’ progress. Since each worksheet was dated, we were able to observe students’ abilities to use evidence to support their learnings over time. We repeated this process for each concept of the sound portion of the unit.

4. **Student Assessment (Appendix E)**

We created a post-assessment based on the State College Primary Division objectives and Pennsylvania State Standards for the sound section of the Light and Sound unit. The students were given one class period to complete the assessment independently. This assessment gave us the opportunity to gain insight into our students’ thinking and analyze our students’ knowledge of sound at the conclusion of the unit. After students completed their post assessments, we went through each question and coded the responses on a separate sheet. We marked correctly answered questions with a plus and those questions that caused students to struggle with a minus. We highlighted the questions with which the students struggled and looked for patterns in the specificity provided in these questions. When reviewing these questions we also noted the relationship between correct answers and the amount of instructional time spent and experiments conducted on individual concepts.

5. **Video Recording of Science Talks (Appendix F)**

We video recorded each science talk throughout the sound portion of the unit. These videos allowed us a visual and auditory representation of every aspect of our science talks. These videos also allowed us the opportunity to go back and view our lessons again, as well as share our lessons and experiences with one another. We used the video editing software program, StudioCode, to analyze and code our videos. Using this program, we were able to select and split our video recorded lessons into several clips. We were able to group, or code, these clips using
specific criteria (Appendix F1). This program allowed us to organize our videos in a timeline format, so we were able to view the occurrences and frequency of the following topics:

- **Teacher Broad Questions** – Teacher asks a non-specific, open ended question to the students, such as “What did you learn today?” or “What do you know about sound?”

- **Teacher Narrow Questions** – Teacher asks a specific question to the students, usually pertaining to experiments students participated in, such as “When you hit the tuning fork against your shoe what did you see and hear?”

- **Student Learning** – Students verbalize a learning constructed during the class period. This learning is recorded on the class KLEW chart.

- **Student Evidence** – Students provide evidence from their experiments that supports their learnings. This evidence is recorded on the class KLEW chart.

- **Student Support** – Students verbally assist one another by clarifying or adding on to an idea or observation discussed during the science talk.

- **Materials/Hands-On Demonstration** – Materials utilized during science experiments are used to enhance students’ understanding of science concepts. Students or teachers recreate parts of experiments that caused disagreement or confusion. Teachers also allow students to test new ideas or theories by using scientific materials.

- **Connections Between Experiments** – Teacher or student verbal response that incorporates or refers to other experiments/materials related to the current experiment to clarify and connect scientific concepts.

After coding our science talk videos, we reviewed and compared the patterns found among the different codes. We looked at the frequency and accuracy of student responses in relation to the type (broad or narrow) of questions asked. We also looked at the change in student response (frequency) and understanding with and without the presence of scientific materials during science talks. When reviewing our coded videos we observed and noted the correlation between student discussion and support and the development of student learnings.

6. **Student Observations (Appendix G)**

During our science lessons we observed and noted student questions, participation, success and struggles. As we observed students we were able to note which type of questions students were
able to answer, and those questions with which they struggled. We were also able to note the amount of support students needed from teachers and peers. We compared the different questions teachers asked (narrow or broad) in relation to the level of understanding provided in students’ responses. After each lesson we reviewed our anecdotal records with one another and looked for similarities and patterns across the two classrooms.

**Explanations and Findings**

Upon completion of our data analysis, we have learned the following regarding how the amount and method of support during science lessons affect students’ abilities to translate observations and experiences into scientific explanations:

**Claim A: Students are best able to construct understandings from their observations when teacher questions are sequenced from narrow to broad.**

**Evidence A1: Student Interviews**

After the completion of our lessons on sound, we each interviewed our students in order to get a better idea of their opinions regarding broad and specific questions during science talks. We wanted to know which type of question students felt more comfortable answering. We discussed examples of both types of questions with students, to make sure that they understood what we were asking. We then asked students which type of question they preferred to answer and why. We found that 35 students (86%) preferred to answer specific questions. These students felt more comfortable with these types of questions because they said that they “knew what the teacher meant by the question”, that specific questions “were easier”, and that they “usually knew the right answer”. When referring to broad questions these students also said that they were “hard to explain”, and “frustrating”. Upon further prompting, these students also said that
they liked specific questions better because they could “think about the experiments and then they knew the answer” (Appendix C1).

Out of the five students who preferred broad questions to specific questions, they were all in high performing reading and math groups and were students who frequently participated in whole and small group discussions. These students said that broad questions were easier for them “because there can be more than one answer”, and “people can share many different ideas”.

There was also one student who responded that he liked both broad and specific questions, but it depended on the question.

**Evidence A2: Scripted conversation between student and teacher**

During a lesson on what makes sound, Miss Ehrlich had a conversation with one of the students in her classroom that was having trouble understanding the concept. She scripted and coded her conversation with this student (Appendix G1). Miss Ehrlich color-coded the text for broad questions and narrow teacher questions, and correct and incorrect student responses. When she asked the student a broad question, the student was unable to generate a correct response 75% of the time. However, when she asked a narrow question that focused on his observations and experiences during the experiment, he was able to provide a correct response 88% of the time.

At the end of the conversation, after eight specific questions, she was able to elicit a correct response from the student when returning to her original broad question of “What makes sound?”.

**Evidence A3: Video recorded science talks**

While teaching a lesson about what sound travels through most effectively, we video recorded teacher questions and student responses. After reviewing our videos we saw that students were able to reach a correct conclusion more often after a series of narrow questions asked by the
teacher, as opposed to only broad questions. Students were not able to generate a well-developed answer after being asked only broad questions. However, after being asked a series of narrow questions, students were not only able to correctly answer these questions, but could also return to and correctly answer the original broad question (Appendix F2). As stated in Primary Science: Taking The Plunge, “The purpose of teachers’ questions should be to promote children’s activity and reasoning” (Elstgeest, 1985, p. 44). As we posed questions to students throughout the science talk, our goal was to encourage students to support their learnings with evidence that they had collected throughout their experimentation.

**Claim B: There is a relationship between repeated exposure to lesson concepts and students’ abilities to make claims and conclusions based on evidence.**

**Evidence B1: Student Post Assessment**

After the completion of our sound lessons, we administered a post assessment to gauge student understanding of the unit objectives. After analyzing student results, we saw that the content area in which students excelled was pitch. Overall, 93% of students were able to correctly answer questions regarding pitch (Appendix E1). After looking over our lessons we realized that students had multiple opportunities to experiment with this topic. Between the two classrooms, students were exposed to nine different experiments illustrating the concept of pitch. The average number of experiments performed for the other concepts between the two classrooms was two experiments. This point can also be illustrated when looking at the assessment question about “What makes sound?”. When students were asked what makes sound, 41/43 students (95%) were able to state that sound is caused by vibrations (Appendix E2). Students participated in four different experiments regarding vibrations. On the other hand, when students were asked a question concerning useful noise and noise pollution, a topic that was covered in only one
lesson and experiment, 30/43 students (70%) were able to provide correct, complete responses (Appendix E3).

**Evidence B2: Student Notebooks**

When analyzing student performance in their scientific notebooks, we noticed that the amount of exposure to a particular topic had a direct correlation to the depth of their explanations. When students were exposed to multiple experiments and worksheets on the same topic, they were able to provide more detailed answers that displayed a higher level of understanding. For example, when completing the first worksheet regarding “What makes sound?”, Student A was unable to explain why the ping pong ball vibrated and made a noise when it came in contact with the tuning fork. However, after several additional experiments, Student A was able to conclude that the sound was caused by vibrations (Appendix D1). Our findings support the research of Jody S. Hall, who concluded, “Children need several exposures to develop ideas about a concept. Also, exploration builds a sense of community and common focus. Children need to do two or three explorations to become highly focused” (1998, p. 37).

**Evidence B3: Student Interviews**

After completing interviews with each of the students, it was clear that multiple experiences with the same concept, as well as the same experiment, were integral to students’ overall understanding of the concept. When reviewing the results of our interview questions we looked specifically at the question, “What did you think when we brought the experiment materials back to our science talks?” As we reviewed our results, we found that 41/43 students (95%) found bringing the materials back to the science talks helped them understand the lesson objectives. One student explained, “We can do the experiments again and that helps me learn” (Appendix C2). There were two students who stated that they did not think it was beneficial to repeat the
experiments during the science talk. These students have both been very academically successful throughout the unit. They both stated that while they already knew the answers and didn’t need to see the experiment again, they thought it was helpful for other students.

Claim C: Students of varying academic abilities require different methods and levels of support from their teachers and peers.

Evidence C1: Student Notebooks

Each student completed worksheets in his/her scientific notebook throughout the unit. The students used these notebooks to record the data they collected during the experiments. Due to the fact that some students are more confident and capable writers than others, we incorporated many opportunities for the students to draw their observations, and label or circle a certain picture or phrase that identified what they were observing. With this format, students who struggled with their writing skills were still able to translate their ideas onto the worksheets and take note of their observations in a way that best met their needs. After analyzing the notebooks of several students in the Title 1 reading group (Appendix D2), it was clear that students who struggled with writing portions of the worksheets were still able to correctly draw, identify, and/or label pictures as required the majority of the time. These findings align with the research of Michael Klentschy, who stated:

Student observations don’t have to be restricted to writing-drawings provide students with a means to shed their preconceptions and see what is actually there…Drawing, sometimes referred to as “graphic speech”, can act as a guide to students’ understanding of science content.” (2005, p. 27)

Differentiated versions of the worksheets (Appendix D3) allowed learning support and ESL learners the opportunity to be fully involved in the experimentation and observation process. Worksheets for these students included simplified wording in the questions, more opportunities to draw, and fewer overall tasks to best meet students’ academic needs.
Evidence C2: Student Interviews

Each student was asked to participate in an interview in which he/she discussed which activities they felt helped them to understand sound (Appendix C3). We wondered if students had a clear, overall preference for the one activity that best assisted their understanding: the KLEW chart, science talks, discussion with peers/teachers, or completing the science worksheets. After totaling the number of students who responded to each item, it was clear that students did not have a single preference for the activity that best helped them understand sound. There was also no significant correlation regarding the students’ reading group/level and the activity that they felt was most crucial to their understanding. When reviewing student interviews there were seven students who said that they found the KLEW charts the most helpful, twelve who chose science talks, ten stated science notebooks, and thirteen claimed that talking with teachers and students was the most helpful to their understanding of sound. Therefore, students have differing, specific needs and require multiple and diverse teaching methods and activities to help them best reach their understandings.

Evidence C3: Scientific Notebook

In the past, we noticed that groups of students with lower reading abilities tend to struggle when placed together on a task that requires them to follow written direction and respond to multiple questions. During each science lesson, students were assembled in heterogeneous groups in relation to their overall academic abilities. We encouraged students to work together as a team of scientists, to help one another complete the sheets in their scientific notebooks and to constantly share ideas. When looking over students’ scientific notebooks we saw that students who normally had trouble in science were able to excel when paired with other, normally high achieving students. For example, Student B required differentiated version of worksheets, and
was often unable to complete the written component of the worksheet without adult assistance. However, when this student was paired with another (high achieving) classmate who engaged her in the task and allowed her to feel like an equal and capable member of the group, Student B exceeded prior performance (Appendix D4).

**Claim D: Opportunities to engage in scientific discussion and collaboration with peers and teachers increases students’ abilities to connect learnings with evidence.**

**Evidence D1: Student Observations**

At the culmination of each of our lessons, students engaged in a science talk. Students frequently added to other students’ comments, and shared their own ideas about what other students had seen and heard (Appendix G). Students also assisted one another by explaining their thinking and helping to clarify other students’ responses. During these science talks, the teacher provided no direct instruction or observations of her own. Instead, she facilitated the conversation by asking guiding questions to keep student discussion moving towards a scientific explanation. Students were able to draw conclusions and reinforce them with evidence at the conclusion of the science talk, after thorough discussion with their peers.

**Evidence D2: Interviews**

When reviewing the responses to the interview question “Was it helpful to you to work with other students when learning about sound?” (Appendix C4), we found that 43/43 students (100%) explained that it was helpful to work in science groups and with partners. When probed for further information, many students explained that they would not have been able to understand what was happening in the experiments without the help of the other children in their science group. Out of the 43 students interviewed, 41 students (95%) explained that being in a group with students who discuss the experiment they are completing and possible explanations for their observations were very helpful to them. Although two students (5%) explained that they
like to work with peers who stay quiet most of the time, they each claimed that it was still helpful to work in a small group, and some things may have been difficult to complete on their own. Further analysis showed the students do not always prefer working with the “smartest” or most high-achieving students in the class. One student explained, “the least smart kids are the most helpful with sharing ideas” (Appendix C4).

**Evidence D3: Student Observations**

After reviewing our anecdotal notes and student observations throughout the sound segment of the unit, we found further evidence to support our claim. When students worked together in small groups, they often conversed about what they were observing and shared their ideas with one another. This exchange of ideas and observations was often what allowed students to reach understandings about the concepts. In such conversations, captured through anecdotal notes (Appendix G2), it can be seen that students use comments made by one another to further their own understandings and share ideas. In this conversation, Mike is able to comprehend the concept that vibrations cause sound only after listening to the comments made by other students. Ken is also able to draw conclusions and state an example of his own after Sally shares her ideas about vibration.

**Reflection and Implication for Future Practice**

The results of this inquiry will be incredibly beneficial for our future teaching. We have come to realize that there are many different and necessary components that need to be in place to best facilitate student learning, and these components must be kept in mind regardless of the grade or content area.
When we teach science, throughout the rest of this year and in the future, we will keep in mind that many students are not able to reach conclusions easily on their own. Instead, they benefit from a sequence of narrow to broad questioning that allows them to put together the pieces on their own in a logical manner. Despite the subject that we are teaching, we will continue to expose children to unit concepts in multiple ways and in multiple forms to help create an environment that fosters meaningful, lifelong learning. For example, reviewing information in various ways, such as guided reading texts and social studies lessons will assist students’ recall of the information.

We also believe that despite the age of the students or the subject matter being taught, providing multiple opportunities for students to discuss what they have observed, read, or experienced with one another is a crucial way for them to develop their own understandings. This will be more beneficial to the students than traditional, teacher-directed instruction.

If we were to teach in the upper-intermediate grades, we would have even less teacher facilitation present in our talks, and encourage the students to speak freely and help one another reach comprehension. Group discussion could be valuable in a multitude of content areas, such as science, poetry, math, and much more. As stated by the Board of Science Education in Ready, Set, Science: Putting Research to Work in K-8 Science Classrooms:

Science can also provide a foundation for continued science learning, as well as for the study of other academic subjects. Students who learn to talk with peers in scientific ways, for example, tracing logical connections among ideas and evidence and criticizing ideas constructively, may employ those skills in other subject areas (Ready, Set, Science, 2007, p. 2).

As we begin to teach the upcoming social studies/science unit, Dinosaurs and Fossils, we will continue to use the information we have gained to set our students up for success. We will facilitate and develop activities in which students of all ability levels will be able to have fun,
participate fully, and learn about dinosaurs and fossils without stress or anxiety. Worksheets in their notebooks will give them opportunities to represent their learning through writing, drawing, and labeling diagrams, and may be differentiated as necessary. Students will be working in cooperative groups throughout this unit to reach a common goal, which will provide opportunities to frequently revisit the information they learned in multiple forms. We will continue to foster discussion among the students, and encourage them to share their ideas and collaborate to reach common understandings.
Appendices:

A. Inquiry Brief and Annotated Bibliography

B. KLEW Chart
   B1: Room 11’s KLEW Chart
   B2: Room 40’s KLEW Chart

C. Student Interviews
   C1: Broad vs. Specific Questioning
   C2: Materials Returned to Science Talks
   C3: Student Interviews-Most Helpful Activities
   C4: Working in Groups

D. Science Notebooks
   D1: Repeated Exposure to Content
   D2: Drawing and Labeling
   D3: Differentiated Worksheets
   D4: Adult vs. Student Assistance

E. Student Assessments
   E1: Pitch Assessment Questions
   E2: Vibration Assessment Questions
   E3: Noise Pollution Assessment Questions

F. Studio Code Images
   F1. Video Recorded Science Talk Codes
   F2. Video Recorded Science Talk Timelines (Narrow – Broad Questioning)

G. Scripted Conversations
   G1. Interactions with John
   G2. Interactions with Sally, Mike, and Ken
Appendix A

Inquiry Brief
Sarah Szymanski and Stacey Ehrlich

Description of Teaching Context:
This inquiry project will be conducted in two self-contained second grade classrooms, room 11 and room 40, at Radio Park Elementary School in State College, Pennsylvania. We are two PDS (Professional Development School) interns who are student teaching for a full year in the State College Area School District. The State College Area School District is a large district located in central Pennsylvania. The district includes one high school, two middle schools, and ten elementary schools, totaling approximately 7,200 students during the 2007-2008 school year. According to the State College Area School District’s mission statement, the district prepares students for lifelong success through excellence in education.

In room 11, there are 10 girls and 12 boys. The age range within the classroom is six to eight years old. There are two African American students, three students who receive ESL services with Chilean, Kuwaiti, and Saudi Arabian backgrounds. One student is of Asian descent, and the remainder of the students are Caucasian. There is a mentor and intern in the classroom at all times, and a paraprofessional present for the majority of the day. The learning and emotional needs of the students in this classroom are quite varied, including three students who receive Title 1 services, three students who attend learning support, three students who attend learning enrichment for mathematics, two students who receive Occupational Therapy for writing, and one student with additional emotional needs. Two students are undergoing IST evaluations. The desks in the classroom are arranged into five clustered groups, with four desks in three groups, and five desks in two groups. This arrangement promotes open communication and facilitates effective group work.

In room 40, there are seven girls and 14 boys. The ages of the students range from seven to eight years old. There are two African American students, one Asian student, one student of Asian and American heritage, and one Middle Eastern student. The remainder of the students are Caucasian. There is a mentor teacher and intern present throughout the school day, and a paraprofessional who remains in the classroom for the morning and early afternoon. The educational needs of the students in room 40 are wide-ranging as well. One student is undergoing a Multidisciplinary Evaluation, and five students receive reading assistance through the Title 1 program. One student requires Occupational Therapy to assist his writing/small motor skills. There are several students obtaining Math Enrichment, and one student attends Learning Support service. The desks in the classroom are arranged into five clusters, with four desks in four of the clusters, and five desks in the last cluster. Similarly to room 11, open communication and positive student collaboration are encouraged and fostered.

Rationale:
In elementary school we both remember science as a time of wonder and experimentation, a time of mystery in which we were permitted to explore the classroom and have fun while wearing silly goggles. What we didn’t remember at the time,
however, was that we were creating knowledge and connections that would last a lifetime. Our goal as teachers is to help students on their path to becoming lifelong learners, and take responsibility and pride in their own learning.

As we began our internship experience, we were eager to take a closer look at the science curriculum and unlock some of the mystery we felt when we were students. Upon beginning our science teaching we noticed that students were participating in and correctly performing science experiments, but when they returned to the science talk they were not able to verbalize their learnings or connect them with the experiments that they had just performed. According to The Regents of the University of California in the *Physics of Sound* Full Option Science System module, “The best way for students to appreciate the scientific enterprise, learn important scientific concepts, and develop the ability to think well is to actively construct ideas through their own inquiries, investigations, and analyses.” (2000, Introduction)

We were worried about our students’ abilities to take full advantage of the inquiry based science approach and translate their observations and experiences into scientific explanations. We wanted to ensure our students opportunities to gain knowledge in all of the strands brought forth by the Board on Science Education, and thus give them the instruction and support that they required. With report cards and parent conferences approaching we still had some doubts as to whether or not our students would meet the science and inquiry benchmarks and would be able to successfully connect their learnings with evidence acquired during science lessons. Our goal as teachers is to provide students with every opportunity to be successful in the classroom and as such, our passion for student learning led us to several wonderings. We wanted to embark on an inquiry project that would allow for student growth and would give students a chance to really take pride in their learning. Therefore, we began our project with the following wonderings:

**Main Wondering:**
How does the structure of science talks, including activities, verbal cues and prompts, and student engagement affect the students’ ability to translate observations into scientific explanations?

**Sub-Questions:**
- How effective are students at citing evidence to back up their learning?
- What happens when students disagree/How do students frame their arguments?
- What kind of teacher support (broad or specific questioning) do students need to construct explanations from their observations?
- What is the role of the KLEW chart and scientific notebooks in constructing student claims?

**Projected Timeline:**

**January**
- January 15th: Unit planning with team teachers to discuss key learning outcomes, materials, and unit timeline.
- January 29th: Organize unit materials into bins and discuss lesson ideas with other team teachers.
February
- Week of February 4th: Begin sound unit. Lessons include: a listening walk and vibrations stations. Meet with Carla Zembal-Saul to discuss teaching science as inquiry and possible collaboration.
- February 8th: Meet with Annmarie Ward to further discuss teaching science as inquiry and possible collaboration.
- Begin learning Studio Code as data analysis tool
- Week of February 11th: Continue sound unit with lessons regarding pitch and volume, and useful sounds vs. noise pollution, and begin to collect video data during science talks.
- Week of February 18th: Continue science teaching regarding the parts of the ear and how sound travels to the ear and continue to collect video data during science talks.
- Week of February 25th: Sound unit commences with lessons demonstrating how sound travels through different materials, and the different materials that can block sound. Administer student assessment to evaluate student learning.
- All lessons commence and conclude with science talks involving a KLEW chart. Data is collected through the KLEW charts, scientific notebooks, video recording, personal reflections, and interviews.

March
- Continue data collection and analysis
- Continue to meet with Carla Zembal-Saul and Annmarie Ward to discuss observations, findings, and questions.
- Compose inquiry paper as data is analyzed

April
- Complete inquiry paper
- Create and present inquiry project presentation
- Continue classroom activities and science talks

Data Collection:
We will be using multiple methods of data collection in order to best analyze the student learning occurring in our classrooms. Also, due to the wide range of student ability levels, our varied approaches to data collection will allow for the most valid and appropriate gauge of student understandings. In addition to these methods of data collection, we will be in constant communication with one another to compare results and observations across classrooms.

Annotated Bibliography
This book addresses the question, “How do I teach primary science more effectively?” We mainly utilized Chapter 4, The Right Question At The Right Time. This chapter focuses on effective teacher questioning. It provides examples of right vs. wrong questions and how to lead students towards an observable response. It talks about “productive questions” and discusses how teachers can incorporate them into their science talks. These productive questions allow students to use their experiences to form conclusions based on experimentation and exploration.


This resource provides a great deal of information about the ways students build scientific theories in the classroom. Through the lens of a child-centered approach, Gallas discusses the role of the teacher in science talks, and how that role will not remain consistent throughout the course of the year. She also includes transcripts of actual science talks. This has provided great ideas for how to structure our science talks, and what questions (broad vs. specific, and how that changes over time) to ask students during the talks throughout the year. It also provided background information about how children “talk to learn,” and the process that they undergo as they create understandings and explanations.


This textbook increased our own background knowledge regarding sound. We utilized Chapter 11 of this book, Waves and Sound, which discusses concepts
such as vibration, sound waves, and sound reflection. This chapter contains an explanation of many key concepts, vocabulary, diagrams, and experiments that will help us expand our specific content knowledge. With a more thorough understanding of sound, we were able to better assist our students and more appropriately guide them through the inquiry process. This also provided us with categories for coding our video in Studio Code.


Due to the fact that we will be using several different methods to lead our students through the inquiry process, this resource will provide us with additional support and ideas. This book contains a wealth of information regarding how to introduce and structure inquiry in the classroom without discouraging student interest and involvement. This resource also offers case studies, teacher reflections, and additional resource books and activities that helped guide us throughout the teaching process.

Zembal-Saul, Carla. Personal interview.

Carla Zembal-Saul is an excellent resource regarding sound content knowledge. She has introduced us to computer programs such as Data Studio and Studio Code, and has given us access to materials to use in our lessons. Contact with Ms. Zembal-Saul throughout the inquiry process has enabled us to share our results, analyze data, construct new ideas, and form conclusion with a respected colleague.


Shouse and Schweingruber’s book contains the most current thinking about effective elementary school science teaching. It includes a wealth of actual classroom experiences, presented through case studies that illustrate the different processes and obstacles teachers face when conducting science lessons. We concentrated mainly on chapter five, which addresses talk and argument during science talks. This chapter demonstrates the parallel between scientists and elementary science learners, which will be helpful, since this is a concept we strive to employ in our classrooms. This resource also provides educators with research collected over the years that demonstrates the importance of reinforcing scientific explanations with evidence.


This book ensures that our inquiry-based teaching will be closely related to the National Science Education Standards. Although it is important that we teach effective science lessons and follow the inquiry process, it is also crucial that our teaching reflects the standards created by the National Academy of Sciences. This book provided a framework for successfully teaching inquiry-based science lessons.

Bortner and Schaeffer’s inquiry project discusses the question of how to take a teacher directed science unit and present it to second graders as an inquiry based unit. This paper also displays the format and shadows the step-by-step process of an inquiry project. Additionally, this inquiry paper is centered on the topic of light, and while our inquiry project will focus on sound, the two are from the same primary science unit. This inquiry project also mirrors much of the same context as our project; our inquiry project also involves two different second grade classrooms, a collaborative working environment, and insight into teaching science as inquiry.


This guide is the original, teacher directed primary science curriculum for light and sound. O’Neill and Lunsford provide a curriculum guide that discusses the basic cores of the unit, technology associated with teaching light and sound, assessment information, a glossary and a projected timeline for teaching this unit. While we are teaching this unit as a more inquiry-based approach to light and sound it was extremely helpful to have a curriculum guide on which to base our instruction. We have utilized the resources and information in this guide as a jumping off point when planning our lessons.

This guide is part of the FOSS (Full Option Science System) kit concerning the physics of sound. Although the guide contains activities, worksheets, and other resources that are geared towards older elementary students, we have been able to adapt many of the activities to suit our own classrooms. The guide also includes a great deal of background knowledge, which has helped us to better understand the subject matter. The lessons in this guide are presented in more of an inquiry-based format than the current State College Area School District unit, and have been quite useful in that regard. Also, the FOSS science kits focus heavily on constant student experimentation and data collection, which lead the students to their ultimate conclusions. Due to the fact that our inquiry project relies heavily on the observations we made regarding the data and evidence that our students collect, this guide has been helpful throughout the inquiry process.


The science notebooks we have created for our students have been very valuable tools to gauge their current understandings as they complete experiments. The data they collected and the observations they made were recorded each time they completed an experiment. We analyzed students’ notebooks to gain insight concerning the observations they made. This article provided concise but beneficial information regarding the essential parts of an effective science notebook. The ideas presented by Klentschy about how to appropriately use the notebooks with elementary students allowed us to create improved worksheets for our students, and thus improve the overall data collection process.
Appendix B

(Appendix B1: Room 11 KLEW Chart)

(Room 40 KLEW Chart)
Appendix C

C1-Student Interviews: Broad vs. Specific Questioning

When I asked you questions in science talks and in your scientific notebook, such as “What did you learn from these experiments” How did you feel? What about when I asked you questions, like “When you hit the coat hanger against the desk and then did it again with your fingers in your ears, which was louder?” Which question was easier for you to answer?

Specific ones - sometimes don't know what to write for others
Don't know how to answer them - frustrating

4. When I asked you questions in science talks and in your scientific notebook, such as “What did you learn from these experiments” How did you feel? What about when I asked you questions, like “When you hit the coat hanger against the desk and then did it again with your fingers in your ears, which was louder?” Which question was easier for you to answer?

N.
Think about experiments. I could remember more.
You actually did what the ? was asking.
4. When I asked you questions in science talks and in your scientific notebook, such as “What did you learn from these experiments” How did you feel? What about when I asked you questions, like “When you hit the coat hanger against the desk and then did it again with your fingers in your ears, which was louder?” Which question was easier for you to answer?

Broad.

Easier because there was more than one answer.

4. When I asked you questions in science talks and in your scientific notebook, such as “What did you learn from these experiments” How did you feel? What about when I asked you questions, like “When you hit the coat hanger against the desk and then did it again with your fingers in your ears, which was louder?” Which question was easier for you to answer?

N.

Easier to figure out.

I could think about experiments.
C2-Student Interviews: Returning Materials to Science Talks

6. What did you think when we brought the experiment materials back to our science talks?

+ I could do the experiments again; that helped me learn.

5. What did you think when we brought the experiment materials back to our science talks?

- Definitely helped
- Different answers than someone else
- Understood more when we did it over again
- About sound was helpful to you

6. What did you think when we brought the experiment materials back to our science talks?

+ I could see it again; we could see what others did; I could understand more.
C3- Student Interviews: Most Helpful Activities

5. Thinking about the science folders, science talks, talking with teachers during experiments, and KLEW chart, what do you think helped you understand what was happening the most?

- Several talks
- Different groups learned different things
- Got to hear what others did and how they did it

The teachers helped evaluate the equipment materials back to our.

5. Thinking about the science folders, science talks, talking with teachers during experiments, and KLEW chart, what do you think helped you understand what was happening the most?

- Science folders needed to understand

5. Thinking about the science folders, science talks, talking with teachers during experiments, and KLEW chart, what do you think helped you understand what was happening the most?

- Talking to teachers and friends
- Put brains together during the experiments in talks

5. Thinking about the science folders, science talks, talking with teachers during experiments, and KLEW chart, what do you think helped you understand what was happening the most?

- KLEW

- Got all our ideas written down
- I could see them
C4-Student Interviews: Working in Groups

7. We have worked together a lot when talking about sound. Was it helpful to you
to work with other students when learning about sound? What part of this helped
you understand sound? Was it helpful to work with certain students more than
others? Why? What part was not helpful? Why?

- Easier when you work w/ someone else.
- If you get stuck you can someone to
help you. You can work together and share
the experiment.
- Good to work w/ different people,

6. What did you think when we brought the experiment materials back to our
science talks? Pretty good, but had different
answers - can figure out if I guessed.
- Good to test over again - good to
know your always redo data.

7. We have worked together a lot when talking about sound. Was it helpful to you
to work with other students when learning about sound? What part of this helped
you understand sound? Was it helpful to work with certain students more than
others? Why? What part was not helpful? Why?

- Sometimes helpful to share ideas w/
other kids.
- Can help others get back on track
- Bad habits - easier to work w/
Max (best friend), Daniel, Kieran helped, talk to
Madison, your, not: Matt (disruptive), Lauren - preferred herself
Appendix D

D1-Student Notebook: Repeated Exposure to Content

**Tuning Fork Test**

Draw the fork before you hit your shoe.  
Draw the fork after you hit your shoe.

What did you see, hear, and feel when you touched the tuning fork to the ping-pong ball and your cheek?

I feel cold and it sound like electricity. The tuning fork shook. The ping pong ball made a buzz.

Why do you think that happened?
D1-Student Notebooks: Repeated Exposure to Content Cont.

Make the inches move!

Draw and label a diagram of your experiment. Be sure to include the desk, the ruler, and your hand.

[Diagram of a ruler and hand against a desk]

What happened when you hit the ruler against the desk? What did you see and hear?

If it’s far out then it makes a soft sound and when it’s far in it makes a loud sound...

Think about what you saw and heard. Why do you think that happened?

The vibration made the ruler make the sound.
D2-Student Notebooks: Use of Drawing and Labeling

Show What Ya Know!

Where did you put your finger to make the HIGHEST PITCH? Put an H on the rubberband.
Where did you put your finger to make the LOWEST PITCH? Put an L on the rubberband.

Rubberband

FREEDICT: Circle the picture that you think will make the HIGHEST PITCH.

Why did that make the highest pitch?

because it was close to the desk.

How do the tuning forks make different pitches?

by hitting soft and hard.
D3- Student Notebooks: Differentiated Versions

One Wet Tuning Fork!

Draw and label a diagram of your experiment. Make sure you include the tuning fork, water, and container.

[Diagram of a tuning fork in water with labels for tuning fork and container]

Write two observations about what happened in your experiment.

When I put the tuning fork in the water, a lot of the water splashed all over the table.

I heard a pretty sound when the tuning fork touched the water.
D4-Student Notebooks: Adult (Inches Move) vs. Student Assistance (Script)

**MAKE THE INCHES MOVE!**

**Draw and label a diagram of your experiment. Be sure to include the desk, the ruler, and your hand.**

When I hit the ruler I saw it **vibrate** when the ruler was sticking way off desk.

When I hit the ruler I heard a **flicking noise**.
PodCast Script

Topic Sentence (What did you learn?):
Person saying this: ___________

our class learned that when you stop whatshoing there is no sound.

Evidence (Why should people believe you?):
Person saying this: ___________

when I hit the tuning fork against my shoe it made a loud sound. But when I put my hand on the tuning fork there was no whatshoing and no sound.

Explain your experiment and what you are going to be showing in your Podcaset (You need to explain everything that you do!):
People saying this: ___________

This is a tuning fork. I will hit it against my shoe. Then, now I will put my hand around the tuning fork. Now it is not breaking.

Wrap-around Sentence (Tell people what you learned. Connect this to your topic sentence!):
Person saying this: ___________

This is how we know that whatshoings there is no sound.
Appendix E

E1-Student Assessments: Pitch

3. Look at the pitch sticks. Write an H under the stick with the highest pitch. Write an L under the stick with the lowest pitch.

Here’s What I Learned!

Color the pitch pipe RED that has the HIGHEST pitch. Color the pitch pipe BLUE that has the LOWEST pitch.

Show me how much water this bottle would need to make a LOW pitch. Draw the water with a crayon.

Show me how much water this bottle would need to make a HIGH pitch. Draw the water with a crayon.
E2-Student Assessments: What Makes Sound?

Think about the L and the E on our KLEW chart. Tell me how sound is made.

You need vibration to make sound.

Tell me two pieces of evidence from our experiments that prove what you said:

1) My cello, whom I'm playing it and I just keep it there, it doesn't make a sound but when I play my cello with my bow the string vibrates.

2) When we put the tuning fork to your shoe, it vibrated and made a noise.

I KNOW SO MUCH ABOUT SOUND!!

1. What makes sound:

I know that vibration makes sound.
E3-Student Assessments: Noise Pollution

2. Read the sounds. Circle if the sound is useful noise or noise pollution.

Music playing at a dance

Useful noise OR Noise pollution

Fire alarm when your house is on fire

Useful noise OR Noise pollution

Your brother yelling outside your bedroom when you are trying to go to sleep

Useful noise OR Noise pollution
Appendix F

Appendix F1: Science Talk Video Codes

Science Video Timeline (F2)
Appendix G

Appendix G1: Interaction with John demonstrating that students benefit from narrow-specific questioning. (February 6, 2008)

Vibration Station (tuning fork)

<table>
<thead>
<tr>
<th>Broad Question</th>
<th>Narrow Question</th>
<th>Correct Response</th>
<th>Incorrect Response</th>
</tr>
</thead>
</table>

Me – **What makes sound?**
John – **The shoe**
Me – Why?
John – Because when you hit the tuning fork on your shoe you hear sound.
Me – **Let’s do it. (Hit tuning fork) What do you see?**
John – It’s moving
Me – **What’s the scientific word that we talked about for when things move back and forth like this?** (pointing to tuning fork)
John – Oh, vibrating
Me – Ok so we see the tuning fork vibration. **Is there anything that we hear?**
John – Yea it makes a buzzing noise, sort of like a ding.
Me – Ok so we see the vibrations and we hear the noise. Let’s think about the ruler experiment. **What did you hear and see there?**
John – I heard the ruler sound like a diving board.
Me – And what did you see?
John – It went back and forth, it vibrated.
Me – So what is making the sound?
John – It was touching something. It was touching the desk. **The desk.**
Me – Let’s think about this. **I wonder if there are things that we saw in both the ruler experiment and the tuning fork experiment?**
John – I don’t know.
Me – **Did you hear anything in the experiments?**
John – Yea, they both made sounds.
Me – And what did they look like? **Is there a word that we could use to describe what happened to the ruler and the tuning fork?**
John – Oh! They vibrated.
Me – **What is it that makes the sound?**
John – Vibrations.
Appendix G2: Interactions with Sally, Mike, and Ken showing that students benefit from peer support. (February 2, 2008)

Group 1: Hallway with tone generator and beans

MS- Ms. Szymanski  
S-Sally (highest reading group)  
M-Mike (lowest reading group)  
K-Ken (lowest reading group)  

MS: So, this tone generator is going to create high and low pitches when I turn it on. Who can give me an example of a high pitch? Who can give me an example of a low pitch?  
(Students make noises)  
MS: Good! Now, listen to the different pitches that are coming out of the speaker.  
(Students listen as the sounds move from low pitch to high pitch)  
MS: I have some dried beans here, and I’m going to put them on top of the speaker. What do you think is going to happen when you place them on the speaker?  
M: I don’t know.  
K: I think they’re going to jump really high.  
S: I think they’re going to move a lot, like crazy.  
MS: Why do you think that’s going to happen?  
S: Because the sound is going to make the speaker mover.  
K: Kinda like what Sally said, it’s the vibration. The sound is making the vibrations and they’ll make the beans jump.  
(Turns on generator and beans start to vibrate)  
MS: What’s happening now?  
M: It’s moving…  
MS: What do we call that?  
M: Vibration. And that’s making the beans move. Because of the sound.  
MS: Does that remind you of anything else we did?  
S: It’s like the experiment with the tuning fork…it vibrated when it was making the sound even though we couldn’t see it vibrating till we touched it on something.  
K: Yeah. It’s like all things vibrate when they make a sound, but you can’t always see it. We could see the ruler on the desk.  
M: But we couldn’t see the speaker vibrating…can I touch it when it’s making the noise? To feel it vibrate?  
(All students feel the speaker and feel it vibrating)