INFORMAL SCIENCE EDUCATION AND ACOUSTICS

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Many people do not know what acoustics is, let alone attend school in order to become acousticians. However, growing evidence shows that ‘non-school’ science programs can stimulate scientific interests and therefore, increase understanding of specific academic and career fields. If adults and children are introduced to acoustics in less ridged or formal settings, they may be more likely to pursue an acoustics education and career. Therefore, in order to increase exposure and access to acoustics, it is important to offer different learning opportunities beyond the traditional classroom framework. This presentation will first discuss informal science education frameworks and science communication methods, such as the National Research Council’s seven strands for learning science in informal settings and flipped pyramid talking points. The presentation will then discuss how the Acoustical Society of America (ASA) employs informal science education strategies in hands-on acoustics demonstration sessions for students, Girl Scouts/Girl Guides, and the general public. Finally, the presentation will conclude with a brief discussion about how scientists and researchers can integrate informal science education strategies into their own research activities.

Keywords: acoustics outreach, informal science education

1. Introduction

Currently, many people do not understand what acoustics is or what acousticians do. This was witnessed first-hand in 2016 when the Acoustical Society of America (ASA) tabled a booth at the Quadrennial Physics Congress (PhysCon), an event geared towards undergraduate students interested in physics. While there, the most common question ASA booth attendants received was, “what is acoustics?” While it is true that many acoustics principals and related phenomena are included in standard K-12 education curriculum, many students will not be introduced to the field or career opportunities until college if ever at all. In the USA, the field of acoustics is often dependent on students accidentally discovering it through college-level coursework and/or personal interactions with professors and acousticians. Unfortunately, there are not many undergraduate institutions in the USA that offer acoustics focused majors. Many colleges and universities have only a few generalized acoustics courses or perhaps sections in engineering or physics. This results in very few undergraduate students discovering the field at all. The question then, is how we can increase the odds of discovering acoustics and ensure students remain interested in pursuing acoustics. One clear option is to reach out and introduce students to acoustics outside the classroom using informal science education techniques.
This paper will first discuss an informal science education framework and science communication methods followed by a discussion about how the ASA employs informal science education (ISE) strategies. Finally, the paper will conclude with a brief discussion about how scientists and researchers can integrate ISE strategies into their own research activities.

2. Informal Science Education

To begin, I must briefly summarize the first chapter in Surrounded by Science: Learning Science in Informal Environments [1]. People spend about 9 percent of their lives in school which leaves significant time for learning science outside of the classroom. ISE has a “special commitment to interest, personal growth, and sustained engagement [...]” that school science education often lacks. The National Research Council developed a framework of “6 Strands” for understanding and promoting scientific knowledge and practice in informal settings. For comparison, the four-strand school model is the same, but lacks Strands 1 and 6. Unlike classroom settings, ISE learners often have the choice to disengage at any point, so it is important that strands 1 and 6 are well supported in any ISE activity.

Strands of Informal Science Education
Strand 1: Sparking interest and excitement.
Strand 2: Understanding scientific content and knowledge.
Strand 3: Engaging in scientific reasoning.
Strand 4: Reflecting on science.
Strand 5: Using the tools and the language of science.
Strand 6: Identifying with the scientific enterprise.

The strands should not be thought of as isolated concepts, but rather as working together to achieve science learning. These strands are interconnected and overlapping. Achieving one, will often correspond with others. The purpose of these strands can help scientists understand how learners learn science and exemplify the mind of proficient science learners. If acousticians design outreach with these 6 Strands in mind, learners will not only have a positive experience with acoustics, they will also be more likely to retain the knowledge and seek out more acoustics educational experiences.

2.1 Outreach

Outreach, sometimes called “public outreach” or “science outreach,” is a combination of science education, science communication and, science policy all geared for the non-scientist, or in this case, the non-acoustician [2]. Acousticians who do outreach are often the publics’ first experience with the field. Whether that be through a lecture series, hands-on demonstration sessions, lab tours, or science blogging, outreach can cultivate an appreciation for and an understanding of acoustics. These outreach acousticians invite the public to get involved, understand, and value acoustics which in turn, can result in K-12 acoustics-based curriculum, increased acoustics research funding, adoption of acoustics standards, and much more. Since an audience made up of non-acousticians would be quite diverse and difficult to address, many outreach initiatives target specific subgroups incorporating communication strategies best suited for each audience to ensure positive engagement and successful learning.

2.2 Science communication

For any outreach effort to be successful, sophisticated concepts must be clearly communicated. [3]. When communicating research to others within the same field, researchers often begin broadly with background information and conclude with results. This approach helps contextualize research; however, it is the reverse of what most lay audiences expect. Science communicators should begin with the core “take-home” message and then broaden to more complex information [4]. This flipped pyramid structure
can be seen in Fig. 1 below. The American Association for the Advancement of Science (AAAS) Communication Toolkit tells the researcher to “[s]tart with the bottom-line in a way that is relevant to the audience, and then share more details” [5].

This communication style pairs well with the strands of ISE. Starting with the bottom line is often a good way to ensure the learners are both interested and will walk away with at least one piece of new scientific knowledge (strands 1 and 2). Then moving on to explain why the bottom line is important encourages learners to engage and reflect on the research findings and implications (strands 3 and 4). Adding supporting details based on the learners’ feedback addresses often address all strands or could be targeted to discuss how the research is being completed or how it was inspired (strands 5 and 6). Any acoustics-based concepts can be adapted to this format.

In Table 1, each pyramid level prompt was used to construct simple talking points about a spectrogram [6]. This particular example has young children in mind, but if the audience is made up of high school students, the message could be more complex, such as different vowels have different visible structures on the spectrogram and these structures are related to how the sounds are produced. It is important to choose one main take-home message to ensure the audience learns it, however if the audience is particularly interested and wants to learn more, offer more information that builds on the first take-home message. In the spectrogram example, if the audience wants to learn more, move on to a discussion about simple and complex sound waves or a discussion about wave structure.

<table>
<thead>
<tr>
<th>Pyramid Points</th>
<th>Talking points</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bottom line</td>
<td>Spectrograms are visualizations of sound waves.</td>
</tr>
<tr>
<td>So what?</td>
<td>Scientists use spectrograms to analyze and understand sound production and perception.</td>
</tr>
<tr>
<td>Supporting Details</td>
<td>Different sounds in speech have different structures visible on the spectrogram. These structures are related to how the sounds are produced.</td>
</tr>
</tbody>
</table>
3. **Acoustical Society of America Outreach**

ASA has been conducting hands-on acoustics demonstration workshops since 1987 [7]. These workshops have been for students, Girl Scouts, Girl Guides, the general public and some for educators. The initial goal of these workshops was simply to provide a public service, generate enthusiasm, build awareness and supplement learning. In 2013, ASA members restructured the workshops based on active learning concepts [7]. The program has remained largely unchanged since these modifications were made [8]. While the “6 Strands” from the list above were not initially used to develop the ASA workshops, it is a good exercise to see how the strands apply and where there is room for improvement. What follows is a description of the current workshop with notations when an activity corresponds to a particular strand.

As guests arrive, an entertaining video is played to spark interest and excitement (Strand 1). After the video, volunteers briefly introduce themselves by saying what area of acoustics they work in (Strands 1 & 6). Attendees visit each station in small groups for about 5-minutes. ASA provides materials for 18 different demonstrations. At each station, volunteers guide the guests through a question-driven exploration of basic acoustics principles (Strand 1, 2 & 4). By asking their own questions, guests are encouraged to find answers by using the station equipment (Strands 3 & 5). At the end of the session, our volunteers describe their educational path and how they ended up in acoustics to show that anyone can be an acoustician and that there are many ways to enter the field (Strand 6). Some workshops include a post-survey which explicitly asks guests to consider whether they would go into acoustics (Strand 6).

While all the strands are important, it is Strand 1 – Sparking Interest and Excitement and Strand 6 – Identify with the scientific enterprise that are important for increasing awareness of acoustics as a field. Once students are excited about the field with activities based on Strand 1, the outreach should get them to think of themselves as acousticians with activities based on Strand 6. The workshop should continue to improve and expand efforts for Strand 6.

4. **Integrating Informal Science Education Outreach with Research**

The first step in integrating ISE into research is to decide what kind of outreach to do. Acoustics outreach could be specific to a very narrow research question or could address an acoustics theme related to the research topic more broadly. On occasion, researchers feel that the type of work they do is not suited for outreach activities because it is boring. This may stem from incorporating poor or unsuitable strategies when presenting material to different audiences or in different settings. For example, while the research may rely on complex mathematical equations it may not be necessary or wise to include them when presenting to young children. Remember to always consider the core take-home message. If the core message ultimately includes concepts about the equation, such as the Fourier transform, think about real world application and how the equation is important for making mp3 files. For example, I would often use the following summarized spectrogram demonstration to complement sociophonetic data collection at a science center.

Start with an interesting question such as “Do you want to see what your speech looks like?” (Strand 1). Once intrigued, show them a running spectrogram. Get them to make different kinds of sounds like clapping, whistling or vowels (Strands 3 & 5). Once they see how the spectrogram responds to sound, ask them if they notice any patterns and if they can figure out what the patterns might represent (Strands 2 & 3). After they make some guesses, explain how the spectrogram is measuring and representing different properties of sound (Strand 2 & 5). Explain how linguists use spectrograms to study speech (Strand 5). Finally, ask them to listen to different sounds at home and think about how their characteristics would be represented on a spectrogram (Strand 6).
Whatever the chosen outreach topic ends up being, the next step is to outline the outreach activity. A basic outline will ensure that the 6 Strands framework is followed, and it will make tracking changes much simpler. There is no fixed outline since outreach comes in many forms. Start by defining the “take-home” message and why it is interesting, important, or novel. Continue to follow the flipped pyramid with more supporting details. Once the outline is completed, test it out on colleagues and make modifications, improvements and additions as necessary before moving on to presenting to your target audience. For more information about how to design and develop an outreach program see [8].

5. Conclusion

This paper serves only as a brief introduction to the widely studied field of informal science education and how it can be leveraged for acoustics outreach efforts. For those interested in incorporating more ISE into their research or even into their curriculum, please refer to the references for detailed resources.

REFERENCES

5. Communicating to Engage, AAAS Communication Toolkit. [Online.] available: https://www.aaas.org/resources/communication-toolkit