Collaborating with Virtual Visiting Scientists to Address Students' Perceptions of Scientists and their Work

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Abstract

The idea that middle school students hold stereotypic representations or impressions of scientists is not new to the field of science education (Barman, 1997; Finson, 2002; Fort & Varney, 1989; Steinke et al., 2007). These representations may match the way scientists are often portrayed in the media in terms of their race (i.e., white), gender (i.e., male), the way they dress (i.e., lab coat, glasses, wild hair), their demeanor (i.e., nerdy, eccentric, anti-social), and where they work (i.e., in a laboratory by themselves). Bringing scientists into classrooms to collaborate with students and teachers has been shown to positively influence students' perceptions of scientists and their work (Bodzin & Gerhinger, 2001; Flick, 1990). However, the planning and collaboration involved in this in-person work can be challenging, complex, and time consuming for both teachers and visiting scientists. Advances in classroom technologies have opened up new opportunities for disrupting problematic representations and supporting students in developing more expansive perceptions of science and scientists. This paper explores the collaboration between a middle school science teacher, five visiting scientists, and a science teacher educator around the development and implementation of a week long virtual visiting scientist program for middle school students. The impact the program had on the teacher's ongoing practice and on students' self-reported perceptions of science and scientists is also examined.

Introduction

For almost forty years we have known that students begin limiting their personal career choices as early as fifth grade in the areas of science and technology (Erb, 1981). Students may also categorize occupations based on gender, which affects the range of possible careers from which they choose (Gettys & Cann, 1981). To further support the idea that one's career aspirations are formed early, Maltese & Tai (2010) found that scientists developed their own interest in science before middle school. More recent studies have found that students' subject interest is also a key factor in their educational and career choices (Angell Henriksen, & Isnes, 2003; Lindahl, 2003). Supporting students in seeing themselves as individuals that can be and become scientists is critical and requires that teachers learn to understand and address students' perceptions of science and scientists from an early age.

Bodzin and Gerhinger (2001) and Flick (1990) reported that visits from scientists in formal classroom settings resulted in a decrease in many stereotypical beliefs about scientists, indicating that students' perceptions can be influenced by visits from professional scientists. More recent work has demonstrated the positive impact week long interactions with various scientists have on middle school girls' appreciation of science within the context of a science camp (Farland-Smith, 2009). Bringing scientists into formal, classroom settings to interact with youth may hold promise in supporting students' development of productive perceptions of science and scientists. However, this approach remains under-researched, particularly from the perspective of classroom teachers working to develop such programs. The development, implementation, and impact of a week long visiting scientist program is described below. The program was the result of a collaboration between a middle school teacher, a teacher educator, visiting scientists, and urban middle school students. The experience was organized around virtual discussion-based interactions between diverse scientists and middle school students.

Initial Motivation for the Project

The middle school teacher had participated in a formal "Scientist-in-Residence" program in years prior, where professional scientists visited the classroom once a week throughout the school year to develop classroom activities with the teacher and work alongside students. The teacher expressed disappointment with the formal in-person visiting scientist program for a variety of reasons, sensing year-after-year it was not always as impactful as it could be. Most significant to the teacher were the challenges of co-designing and implementing science learning activities with scientists who lacked fundamental pedagogical knowledge and training. The teacher expressed that the focus on co-designing and implementing science learning activities (with little time or resources to support this work) resulted in ineffective activities and overlooked the meaningful identity work that could emerge from more informal interactions between middle school students and scientists.

The teacher's interest in re-structuring the visiting scientist program led them to reach out to a teacher educator who had conducted research in this area. Through a series of initial conversations, the teacher expressed an interest in finding ways to support their students in seeing themselves as individuals that could be and become scientists. The teacher expressed interest in designing a visiting scientist experience that foregrounded more informal student-scientist interactions, with the goal of advancing students' perceptions of scientists and their work. While the teacher was confident in the value of the program, they expressed uncertainty as to whether or not the principal of the school could be convinced that it would be a valuable use of classroom time and would approve of such a program. The teacher educator, having conducted research in this area, had data to support such a collaboration. The teacher educator and the teacher discussed the many possible benefits of the program for youth, including: providing opportunities for students to see themselves as individuals that could become scientists, supporting students in seeing the "human side" of

science, disrupting the stereotypes that many youth hold about scientists, and bringing *NGSS* dimensions to life. The teacher brought up these key points to the principal of the school and the program was approved by the principal.

Selection of Scientists

Structuring the program around virtual discussion-based student-scientist interactions provided a range of affordances that would not have been possible if the program were structured around in- person visiting scientists. For example, the teacher was able to reach out to and select scientists from across the country that may have been outside of commuting range to the school. Additionally, the virtual format made the experience more responsive to the daily time constraints faced by scientists. Instead of commuting to the middle school classroom, scientists were able to virtually bring the middle school students into their laboratories, homes, and workspaces.

Visiting scientists were selected to represent a range of scientific, educational, racial, ethnic, and linguistic backgrounds. Visiting scientists came from various colleges and universities. In addition to representing various scientific disciplines, including earth, physical, and life sciences, visiting scientists represented a range of time points in their scientific careers, including tenured faculty, post-doctoral researchers, doctoral students, and undergraduate researchers. All visiting scientists were willing and eager participants. Several scientists had prior experience working with middle school students and were enthusiastic about the opportunity to virtually engage with students.

Visiting Scientists

Dr. Maria (Visiting Scientist #1) was a white female professor in a biology department at a small liberal arts college in the Midwestern United States. Dr. Maria and her team of undergraduate research students study the ecology of arthropod-borne disease. Dr. Maria was joined by four undergraduate research students that included one Black female, one white male, and two white females. Dr. Julia (Visiting Scientist #2) was an Asian-American female Associate Research Scientist at a large private urban research university in the Northeastern United States. Dr. Julia studies water resource risk analysis and large-scale climate variability. Mr. Vee (Visiting Scientist #3) was a Latino male doctoral student in physics at an urban public university in the Northeastern United States. Mr. Vee was interested in using mathematics to study weather patterns. Dr. Lucas (Visiting Scientist #4) was a Latino male Associate Research Scientist at a large private urban university in the Northeastern United States interested in applying computer science and mathematics to environmental issues. Dr. Sebastian (Visiting Scientist #5) was a Latino male post-doctoral researcher at a large private research university located in the West Coast of the United States interested in the neural basis of animal behavior.

Initial Planning with Scientists

In initial emails to scientists, the teacher highlighted the importance of informal discussions with students throughout the virtual sessions. The teacher emphasized sharing ideas and experiences and responding to students' thoughts and questions over "teaching specific facts about science." After scientists agreed to participate in the program, the teacher attempted to guide the scientists by introducing the overarching aim of the program and outlining the structure of each session via email. The teacher shared that the aim of the session was to provide opportunities for students to develop their perceptions of scientists and their work. In the email, the teacher then described that each session would be split into two parts, part A and part B, with each part being 15-20 minutes in length. For part A, scientists would be encouraged to introduce themselves and their personal and scientific backgrounds, describe their experiences pursuing a career in science, describe their scientific work at the middle school level, and share pictures and media that demonstrate their work. For Part B, scientists were encouraged to field questions from students and engage in informal student-led discussions. Scientists were informed that most students had a basic understanding of topics in chemistry, geology, biology, and physics and that many students in the class were English language learners. In the email, the teacher encouraged visiting scientists to reply with any relevant questions or concerns.

Dr. Maria replied to the initial email from the teacher by suggesting that they video chat from the entomology lab so that students could see their workspace and scientific equipment. Dr. Maria also asked if she could include several of her undergraduate research students in the session. Dr. Julia, Mr. Vee, and Dr. Lucas replied to the initial email by confirming they were excited to participate in the session and that they understood the aim and outline of the sessions. They did not reply with any questions or concerns. Dr. Sebastian proposed four possible scientific projects to discuss with students and asked the teacher for advice for which project might be most interesting and relevant to students.

Student Preparation by the Teacher

Several days prior to the visiting scientist sessions, students were given opportunities to devise questions that they might like to ask a scientist, with students being encouraged to generate a broad range of questions. The teacher modeled some of the questions students might ask, such as "why did you become a scientist?" and "what was the hardest part of becoming a scientist?" Students then generated questions in groups and individually. During sessions, students had access to the lists of questions they generated. In between sessions with scientists, students completed reflections in response to the following prompt: "What do you think were the best questions asked during the previous session? Why?" Some examples of student generated questions were:

- "Why do you think science is important?"
- "How did you feel about science class when you were in 7th grade?"
- "Are you friends with the people you work with?"
- "Has anyone ever told you couldn't be a scientist?"

- “Do you enjoy your job?”
- “Have you ever felt like giving up?”
- “What steps did you take to get to where you are today?”
- “Do you have any advice for a middle school student interested in becoming a scientist?”

Program Setting

Five professional scientists (two females and three males) located in different regions of the United States interacted with 27 middle school students during a one-week experience conducted solely over a video chat application. The sessions were held in the middle school classroom and required minimal technology upgrades, including speakers and a camera with built in microphone. The program took place in a Title 1 middle school in one of the largest public school districts in the United States. At the time of study, there were 1308 total students enrolled in the middle school (60% Hispanic, 19% Asian, 11% White, and 10% Black). 81% of students were eligible for free or reduced priced lunch. 27% of students had disabilities. 14% of students were English language learners. The most common languages spoken at this particular school, other than English, included Spanish, Chinese (Mandarin), Arabic, Tagalog, and Urdu.

Virtual Discussion-based Student-Scientist Interactions

Scientists spent the first portion of each session introducing themselves and their work. Scientists introduced their work by visually representing the concepts they study and the research tools they use.

Dr. Maria’s session began with her and undergraduate researchers describing how they came to become scientists, what they love about science, and what scientific questions are interesting and meaningful to them. Before engaging in informal student-led discussions, Dr. Maria and her research team described a current research project they were working on that involved studying why mosquitoes have a preference to prey on one species of bird over another. They used images to demonstrate related concepts, such as how mosquito-borne diseases are spread, and gave students a virtual tour of their research space, including the various research tools and apparatuses they use.

Dr. Julia began her session by describing the role her family and other personal relationships played in developing her interests in science. She also described the steps she took to get to her current position. Dr. Julia then described her interest in studying how amounts of available water change across time and space. She used a screen-sharing tool to present graphs and diagrams that demonstrated the concepts central to her research. She also showcased the tools she uses to collect data on water availability in the field.

Before engaging in informal student-led discussions, Mr. Vee described how his secondary school science experiences shaped the development of his interests in science. He then used a screen-sharing tool to share visuals that helped him describe how he uses mathematics to study storms.

Before engaging in informal student-led discussions, Dr. Lucas described the steps he took to get to his current position and the ways scientists can use mathematics to examine various phenomena. He also described his interests outside of science, including music and dancing. Dr. Lucas used a screen-sharing tool to share a video on the science of facial recognition in order to help students understand the ways in which computer science can be used to recognize patterns and objects. He described the ways in which he uses similar technology to identify parts of large mines around the world that could be potentially harmful to the Earth.

Dr. Sebastian began his session by describing how his interest in science came from his love of animals as a child and early interest in wondering what was happening inside of their heads. He said he continues to ask the same questions in his science lab, where he studies how the brain enables mosquitoes to make decisions. Dr. Sebastian then used a screen-sharing tool to present visuals to aid in his description of the mosquito life cycle and mosquito behavior. He also shared videos of experiments examining the factors that help mosquitoes track their prey.

After completing Part A of their sessions, scientists subsequently engaged in informal student-led discussions driven by student-generated questions. Scientists spent a significant amount of time responding to students' ideas and students' questions about their personal lives and jobs. Students were encouraged to direct the conversation by calling on each other to speak and call on students whose voices were not heard yet in the discussion.

Students' Perceptions of the Virtual Visiting Scientist Program

In the week following the virtual visiting scientist program, students were asked to reflect on their experiences during the program by responding to the following prompts: 1) What did you think about last week's [virtual visiting scientist] program?; 2) Do you think it was a valuable experience? Explain why or why not?; 3) Did the program change how you think about scientists and what they do? If so, explain how?; and 4) What was the most interesting thing you learned during last week's session? While many responses reflected new understandings of scientific content and practices, the majority of responses focused on more general, personal insight students gained about scientists and the work that scientists do. Below are sample responses to each question.

Sample Student responses to "What did you think about last week's program?"

> • "…I think the [virtual visiting scientist] program was really cool and interesting. Because it was the first time seeing a scientists [sic] and asking them questions…"
>
> • "It was pretty cool last week on [virtual visiting scientist] week because I met a scientist in person and I have never met a scientist in person in my life before…"
>
> • "We got to meet 5 smart scientists it was really interesting and I could not wait for the next day to meet another person to ask more questions…"
>
> • "It was the first time I got face-to-face with a real scientist and know about what they are doing in real life. Also, I got the chance to ask scientists questions."

Sample Student Responses to "Do you think it was a valuable experience? Explain why or why not?"

> • "…I think it's good because not all kids get to talk or know these scientists."
>
> • "…I think it was a valuable experience because we learned many things and found answers to our questions. For example if Mr. [Teacher] did not know we asked the scientist and they knew."
>
> • "Yes…I do believe it was valuable experience because it let us take a break from doing research and let us watch where other people's research have gotten them in life and how they achieved their own goals."
>
> • "…I think this was a valuable experience because not many kids get to speak to famous scientists, and talk about their personal stuff and about science."

Sample Student Responses to "Did the program change how you think about scientists and what they do? If so, explain how?"

> • "…Yes, it changed how I view scientists I know for a fact all scientists are not guys who are white and old but it's just how I knew scientists were…"
>
> • "…Yes, the program changed the mine set of scientist only wear glasses, white jackets, and crazy hair but now when I saw them I know what they look like they are just normal."
>
> • "…I now they can work inside and out if they need to and they are completely normal no crazy white hair or thirst for knowledge enough to bring the dead back to life."
>
> • "The way I think about scientists has changed because I always thought the scientists always worked in labs no matter what, but from the [virtual visiting scientist program] sessions everyone said they had worked from home at times…"
>
> • "…the program did change my view on scientists because I thought that they were these boring people who search up the same stuff over and over again. Now I know that they are these cool people who search up anything to find out what's behind the curtain…"
>
> • "I thought scientists were people who stood in labs and just focused on one thing, now I know they do so many things to figure out one thing. They focus on every little thing to find out what they need to find out…"

Sample Student Responses to "What was the most interesting thing you learned during last week's session?"

> • "…The most interesting thing I heard in this session was that there are scientists that collect data and that scientists does coding. I never thought scientist do coding…"
>
> • "…the most interesting thing I learned about the scientist last week is that the lab they go to in the pictures of them showed (if that was the lab, I don't know) quickly to us."
>
> • "…I thought other things that scientists did like experiments and there they be in a lab or somewhere but not there all the time…"
>
> • "…the only kind of thing that changed what I thought of the scientist was that I know that they work and discover new things or uncover things that are confusing or has not enough information on that topic, but one thing they did not change about how I think scientist is their work and how they do their work, they also helped me figure out REAL scientists looked like and where they live and what they do in the lab…"

Teacher's Perceptions of the Virtual Visiting Scientist Program

The teacher expressed noticing a “shift” in student investment in science class after the week long virtual visiting scientist program. The teacher reported that students expressed a greater interest in science, with many students believing that they could become professional scientists if they wanted to. The teacher reported leveraging this experience throughout the school year, frequently returning to the questions and ideas that came up during the sessions. They expressed an interest taking more time away from standard science content in class in order to explore personal and historical accounts of diverse scientists. The teacher also expressed a commitment to continuing to take class time to focus on the “human side” of science and support students in identifying as individuals that can be and become scientists.

Discussion

The goal of the program, as identified early on in the partnership between the teacher and the teacher educator, was to provide students with opportunities to engage in informal discussion-based interactions with a variety of scientists. The ultimate purpose of the experience was to advance students’ perceptions of science and scientists, and support students in identifying as individuals that could be and become scientists.

The program appeared to be productive for both the students and the teacher involved. Rather than leaving students with a singular impression of a scientist, this project exposed students to a range of scientific work and individual scientists. This may have contributed to a shift in students’ perceptions of scientists, as one student reported: “the program changed the mine set of scientist only wear glasses, white jackets, and crazy hair but now when I saw them I know what they look like they are just normal.” The teacher indicated seeing increased value in this work and expressed a commitment to continuing to center the identities of scientists and students in their science class. While some benefits of the program were immediately visible, it is difficult to comprehensively measure the impact interactions with the scientists had on the teacher’s ongoing practice and on students’ perceptions of science and scientists. Future longitudinal work might elucidate the full impact similar programs have on the students and teachers involved.

In an era of heightened testing and accountability, educators may feel reluctant to use planning time, resources, and classroom time for visiting scientist programs. Additionally, teachers and teacher educators may not know the most effective and efficient ways to develop partnerships with visiting scientists in order to advance students perceptions of scientists and their work. Collaborating with virtual visiting scientists in the ways outlined in this article may prove to be a valuable endeavor for both teachers and students. We hope that the case described above will support teachers and teacher educators in seeing the possibilities of setting aside precious classroom time in order to engage in this work.

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