

5-1-2014

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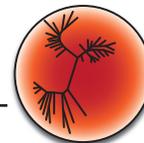
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Science Café Course: An Innovative Means of Improving Communication Skills of Undergraduate Biology Majors

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To help bridge the increasing gap between scientists and the public, we developed an innovative two-semester course called Science Café. In this course, undergraduate biology majors learn to develop communication skills to be better able to explain science concepts and current developments in science to non-scientists. Students develop and host outreach events on various topics relevant to the community, thereby increasing interactions between budding scientists and the public. Such a Science Café course emphasizes development of science communication skills early, at the undergraduate level, and empowers students to use their science knowledge in everyday interactions with the public to increase science literacy, get involved in the local community and engage the public in a dialogue on various pressing science issues. We believe that undergraduate science majors can be great ambassadors for science and are often overlooked since many aspire to go on to medical/veterinary/pharmacy schools. However, science communication skills are especially important for these types of students because when they become healthcare professionals, they will interact with the public as part of their everyday jobs and can thus be great representatives for the field.

INTRODUCTION

“You do not really understand something unless you can explain it to your grandmother.”

– Albert Einstein

One of the main challenges scientists face in the 21st century is relaying scientific information to the public accurately and clearly. When many scientific findings impact governmental policies including healthcare (e.g. stem cell research) and energy bills (e.g. the development of alternative energy sources), the ability of the public to interpret these findings directly affects their votes, as well as the future of science funding.

Multiple reasons for America’s poor science literacy have been suggested, including the poor quality of science education in the K–12 systems, failure of scientists to make their findings understandable and accessible to the public, as well as the inability of the media to relay scientific findings accurately and in an accessible language to the public (6, 8, 15, 19). Scientists feel that scientific findings are often over-simplified and misrepresented by the media to reflect

political agendas, sensationalizing the negative without providing objective, accurate information (3, 6, 12). Journalists in turn feel that scientists are not doing a good job of communicating the significance of their work as well as failing to understand the journalistic process (2, 12). Bridging the divide between scientists and the public has not been easy. While programs like “The Naked Scientists,” in England (see <http://www.thenakedscientists.com/>), and NPR Science Friday, Myth busters, and Radio Lab (see <http://www.radiolab.org>), in the United States, use various media formats to demystify science and make it accessible to the general public, to the best of our knowledge, in academia, at the undergraduate and graduate levels, little emphasis has been placed on developing curricula that train scientists to communicate with the public.

Because most scientists discuss their work with like-minded colleagues at conferences and via peer-reviewed publications, there are few opportunities to realize the gap between public understanding and what most scientists assume is “common knowledge” (4, 9). Common gaps in understanding are often realized during policy debates on topics such as stem cell research and climate change (9, 14). These gaps are further increased by oversimplified reporting, where scientific breakthroughs emphasize the actual finding, while minimizing essential methodology and relevant background that can be vital for understanding the context of the breakthrough (1, 8, 9). Similarly, the basic process of the scientific method is often misunderstood by the public, who often misinterprets the term “theory” as

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a lack of sufficient evidence or as uncertainty about well-accepted, scientifically supported concepts (e.g. climate change, evolution) (7, 9).

The communication gap is further widened by the disparate set of communication skills scientists need to communicate with peers and with non-scientists. Most scientists learn communication skills by cultural transmission, learning discipline-specific, technical jargon to explain their research to others in the field, often in a few short sentences (e.g. the elevator talk). Many scientists never receive formal training to be able to communicate effectively. At the graduate level, effective communication skills tend to be learned through highly variable lab cultures, during lab meetings. Since members of the same research lab tend to all be scientists at different stages of their career, they share a passion for the particular lab research topic and are trained in the specific jargon/terminology used to discuss this research. Thus, while lab meetings provide essential training for future scientists to communicate with other scientists, these skills do not translate easily to the communication skills necessary for scientists to speak to people who are not part of their research field, are not familiar with the research topic, or lack a science background (1, 18). Based on an informal survey within our department and of faculty from other universities, at the undergraduate level, communication skills are emphasized mainly in senior seminar courses. However, due to time constraints, these courses typically require only one oral presentation for the entire semester. These presentations typically focus on communication with peers, rather than non-scientists. Thus, by the time undergraduate biology majors enter their senior year, most have never given a scientific presentation and even fewer have spoken to non-scientists about science.

Considering the lack of formal and consistent training available for science majors and scientists to improve their communication with other scientists, it is no surprise that limited emphasis has been placed on developing communication skills to relay complex scientific concepts to the public. While a few initiatives have begun to sprout across the country (11, 16) there is no cohesive, organized training program aimed at teaching scientists (upcoming and established) to explain research and scientific concepts to non-scientists (e.g. elevator talk for the non-science-minded grandmother). Yet, there is evidence that communication workshops improve the ability of scientists to communicate with the media and to explain their research to non-scientists (2, 16).

We argue that at least one of the approaches to increase public interest in science, as well as overall science literacy, is to develop communication skills early, starting with undergraduate science majors. We developed an innovative two-semester course, Science Café, to help narrow the gap in the public's understanding of science, and instill a culture of wanting to engage the non-scientist in talking about science with passion. We developed a Science Café

course based on the international Science Café grassroots movement (<http://www.cafescientifique.org/>, <http://www.sciencecafes.org/>), where non-scientists and scientists gather in informal settings (e.g. pubs, coffee houses, restaurants, libraries, etc.) to engage in lively debates on specific topics (5; <http://www.informallearning.com/archive/Desai-75.htm>). In these gatherings, topics vary widely, but often reflect the interests of the organizers, who can be scientists, educators, and the community.

The Science Café course is part of an integrative QBIC (Quantifying Biology In the Classroom) program (17). Funded by our institution, FIU, NIH and NSF, QBIC is a STEM program created in response to the Bio 2010 initiative of the National Academies of Science (11). QBIC aims to increase scientific literacy of undergraduate biology majors through exposure to scientific literature beyond textbooks starting with their first semester in college. Admission into the program is based on academic merit (minimum 3.0 unweighted high-school GPA, 1750 SAT/ACT cumulative score, successful completion of pre-calculus), a personal statement, two letters of recommendation, and completion of the program application (qbic.fiu.edu/prospective.html).

During the first three years of their undergraduate education, QBIC scholars are enrolled each semester in a one-credit course called QBIC Journal Club. QBIC Journal Club fosters interactive discussions with small groups of 8 to 10 students, where the facilitator directs them to make connections between specific concepts in research papers and the same concepts in their other courses. During this time, students learn to read and interpret research articles and discuss scientifically complex ideas using information they learn in their science and math lecture and lab courses. Freshmen start out reading popular science literature, such as "Why we get sick" (13) and "The beak of the finch" (19), to discuss the basic tenets of evolution, and articles from journals like *American Scientist* and *The Scientist* to supplement their textbook readings. Thus the first three years of the program are aimed at teaching students to speak "biology" to be able to use scientific terminology in regular discourse. In the final year, in their Science Café course, students use their science background, ability to interpret scientific literature, and communication skills learned in the preceding years to communicate scientifically complex concepts in an engaging, easy to understand manner to non-scientists. The Science Café course is a mandatory part of the Journal Club sequence and is typically composed of 8 to 15 students per section. There are typically two sections. All students in the QBIC program are required to take Journal Club and the Science Café courses.

Science Café I

The QBIC Science Café is a two-semester course guided by an instructor, but driven by the students themselves. The students use the skills they learned in years of Journal Club to develop public outreach events (i.e. science

cafés). During the fall semester of their senior year (Science Café I), QBIC scholars are exposed to the history of science cafés, pay close attention to science news in their community and practice communicating scientific research with each other in class. They spend a lot of time practicing how to explain scientific concepts in layman's language without using "science-speak," and without sounding patronizing or condescending. Each class starts with a discussion of current science news where students explain to their classmates, without using science jargon, the significance of reported findings and their implications for future research and applicability to everyday life. Students also participate in writing exercises where they spend time reading primary literature on a topic of their choice. They are then asked to write a popular science article on the same topic. These exercises are designed to challenge students to think about and present scientific information in an engaging, clear language.

To gauge public interest and choose outreach topics that are important to the community, for example, students in the 2011 class developed a survey that they distributed to 250 people. By conducting these surveys, students gained an additional opportunity to communicate with the public about science and gauge public attitude toward science. Because the Science Café topics were highly varied and could be potentially of interest to a wide audience, students distributed the survey at various locations, including a nearby major grocery store, students on campus, and places of employment of their parents (some of which included middle schools, hospitals, and engineering firms). Based on the results of the survey, they chose topics (Table I) for their own Science Café events that they hosted the following semester.

Part of the preparation for these events involved gathering and reading a lot of primary literature and learning the latest findings on specific topics planned for the Science Cafés. Then, depending on the intended audience and venue, students developed creative ways to present their topics in an engaging, intellectually stimulating manner to the public. Students designed their presentations and the manner in which the presentations were conducted to reflect the potential audience. For example, the Science Café event "How can we see colors?" (Table I) was designed for a 5th grade level audience. Therefore the presentation was composed of many interactive activities, with lots of questions and prizes to engage and maintain student interest. "Nutrition in 2012" was geared toward families, adults, and children. To provide useful information to adults, while maintaining the interest of children, students used PowerPoint presentations, handouts, and a cooking demo where children in the audience were invited to help prepare a healthy meal. In all Science Café events, we invited the public to ask questions and comment throughout the presentation, creating an informal, comfortable environment to discuss the topics. At the end of each presentation, time was allotted for questions, as well as informal smaller discussions between the presenters and members of the audience.

TABLE I.

List of Science Cafés developed and hosted by students.

Event Title and Description ^a	Target Audience
<p>Alternative energy: how many ways can you spin a wheel? Developed activities to show 1) the diminishing amounts of oil for fuel, 2) how wind and heat can be converted to energy, and 3) how much energy is necessary to power various household items.</p>	Elementary and middle school children
<p>Biology of cancer Hosted a guest speaker and discussed what is cancer and the greatest risk factors for developing cancer as it relates to living in Florida. Students introduced current treatments and new drugs in trials for treating melanoma.</p>	Adults
<p>Nutrition in 2012 Discussed the new nutritional guidelines of the Food Plate, which replaced the Food Pyramid. Developed a demo to show how to create family-friendly meals that meet the Food Plate suggestions; children from the audience assisted with meal preparation</p>	Adults and children
<p>Stem cell and disease therapy Hosted an invited speaker from the Harvard Stem Cell Institute to discuss what stem cell research entails, as well as its potential for developing treatments for various diseases.</p>	Adults
<p>Bad things that are actually good for you! Discussed some of the commonly accepted activities that are viewed as social taboos and the scientific evidence suggesting their health benefits.</p>	University students
<p>How can we see colors? Developed age-appropriate activities to explain the physics of color and color-vision.</p>	Elementary school children

^a The first four events were held in collaboration with a local museum.

Science Café II

In the spring semester (Science Café II), scholars implement the skills they learned to host science cafés. Some events include experts in the theme explored, while others are hosted and presented by the students themselves. During these events, students have the opportunity to contribute to increasing public interest in and understanding of science, to stimulate dialogue between scientists and the public, inform the general public about scientific topics, while countering common myths, distortions and misinformation associated with a wide range of scientific topics. Over the past two years, we have held multiple events, with highly variable topics and audiences

(Table I). To increase exposure and increase attendance, all events were advertised in the local newspapers, university newspaper, and by posting student-created flyers at the university and around the areas where the events were held. For local newspapers, we submitted a short piece describing the event, with pertinent details including date, location, and the type of audience the event was geared for. For the university newspaper, we submitted a flyer about the event to be published in the newspaper prior to the event. In addition, university journalists attended some of the events and wrote articles about them, as well as the Science Café course. The events have been well attended and received by the public. Based on exit surveys given at the end of each Science Café, all attendees said that they would be willing to attend future events.

Student performance was measured based on multiple criteria, including creativity, knowledge of subject content, willingness to take initiative to help develop the project, meeting deadlines, punctuality, and the ability to work in a group. Throughout the course of the semester, individual groups met regularly with the instructor to discuss the progress of their Science Café events, test ideas, plan activities and practice their presentations. As the event date approached, groups presented their Science Cafés to the entire class to get feedback and suggestions for improvement. In addition, all QBIC faculty and students were invited to attend these practice sessions and provide feedback. These practice sessions occurred multiple times prior to the actual event. At the end of the semester, after the completion of group Science Cafés, each student filled out an exit survey to assess his/her group members. Peer assessments were used to assess how well students worked within their group without instructor supervision. The collective peer assessments were used to help determine the final student grade.

The goal of this course has been two-fold: to empower the students to use their knowledge in everyday interactions with the public, not simply for entrance exams into graduate/medical schools. In addition, science cafés have been a great way to increase science literacy and for students to get involved in the local community and engage the public in a dialogue on various pressing science issues. The type of informal instruction that we have used in science café events has been highly effective in getting the public engaged in the scientific process (10, 16). Importantly, at the end of the spring semester, after implementing their events, the majority of the students felt that their ability to communicate with scientists and non-scientists improved. In addition, by participating in every part of the Science Café development, from surveying the public to designing and developing the actual topic, students felt confident that each of them could develop and host similar events in the future. We are encouraged by the feedback we have gotten from students and feel that with minor adjustments, this course can be expanded to larger cohorts.

CONCLUSION

While the majority of undergraduate science majors pursue science with hopes of being admitted into medical, dental, or veterinary schools, they are also the liaisons between the scientific discipline and the public. Whether future doctors or academics, undergraduate science majors need to be able to communicate what they learn. In addition, upon receiving a Bachelor's degree in biology, students should have the necessary knowledge to make informed decisions about policy issues (i.e. vote) and be better able to explain the significance of these issues to the public.

A common expectation of language proficiency is an ability to not only read and write, but also to comprehend and speak the language of interest. If science majors cannot explain the basic tenets of their chosen science field by the time they receive their Bachelor's diplomas, our success as educators should come into question. An undergraduate degree in any science discipline should result in at least a mastery of the basic concepts and jargon, along with the skills needed to translate and communicate those ideas to non-speakers (i.e. the general public). We need to teach our undergraduate and graduate students to not only give an elevator talk, but to be able to give this talk to their non-scientist grandparent. By not teaching our undergraduates to communicate their knowledge to friends, future patients, parents, and grandparents, we lose potential science ambassadors. In a time when every political, economic, and social issue is loaded with science inferences and has important implications for the future of science, we cannot afford that.

ACKNOWLEDGMENTS

This program is supported in part by NIH grant # GM078004-05 and Florida International University intramural funds. The Science Café course has been supported by the QBIC program funds. We thank Marcy Lowenstein, Sat Gavassa, and Martin Tracey for helpful discussions and anonymous reviewers for helpful comments on this manuscript. We also thank all the QBIC students who participated in the development of the Science Café course. The authors declare that there are no conflicts of interest.

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