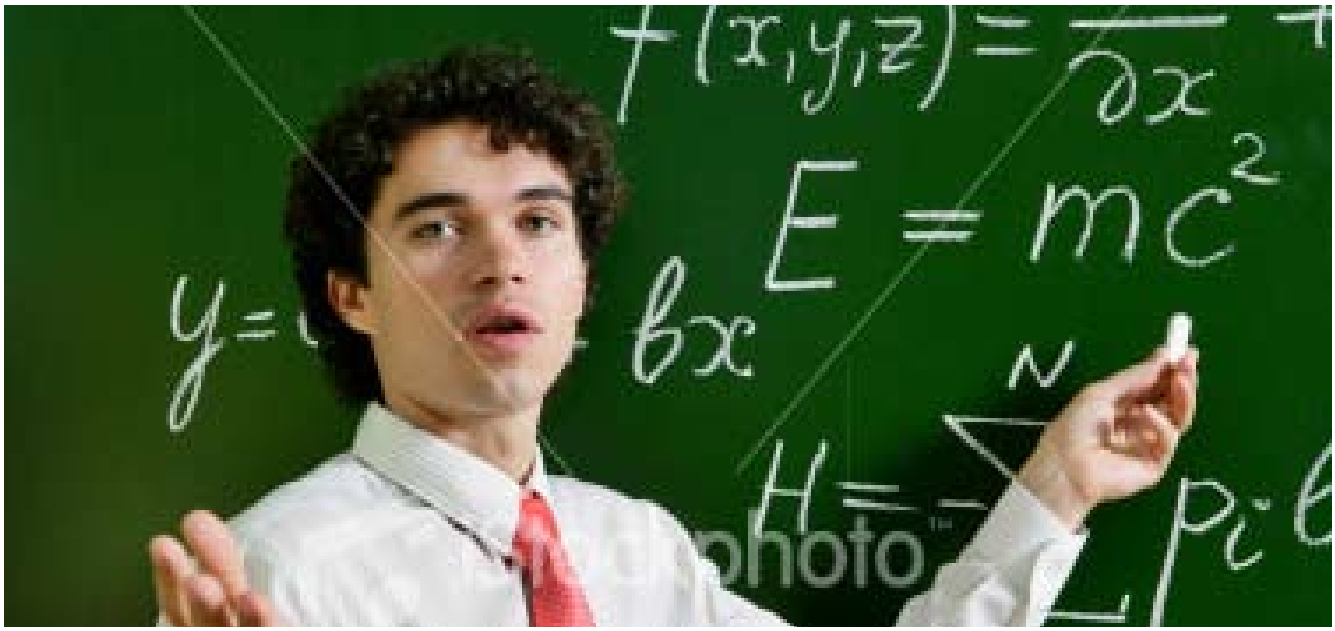
Science and Me: A Student-Driven Science Outreach Program for Lay Adult Audiences



By Hannah Alexander, Anna M. Waldron, and Sandra K. Abell

The increasing need for communicating science to the public suggests that future scientists and science educators should be educated in science outreach and trained to communicate with lay audiences. We present a recently developed novel graduate course, which trains students in outreach efforts aimed to increase the public's understanding of science and of the role of science in our daily lives. In this course, the students, with the help of expert faculty mentors, prepare lay-language presentations about science-related topics of their choice and take the presentations to adult venues in the community. This article provides a detailed description of the course and its impact on the students and the audiences, and it discusses challenges encountered and lessons learned that will support others interested in attempting such a program.

Appreciation for science, trust in science, and support of science vary a great deal across societies, cultures, ages, and levels of education. They range from awe and reverence on one end, to complete distrust and dismissal at the other end. In some societies, the public possesses at least some awareness of the role of science in society, some recognition of the contribution science makes to everyday life, and some understanding of the value of basic scientific research in generating a body of knowledge that can be drawn on in the future. Yet in other instances, we find mistrust, lack of appreciation for science, and lack of awareness of the immense role science plays in our daily lives (Miller 2004).

There are many reasons for these different attitudes. We believe that one major contributing factor is the increasing disconnect between the adult public and scientists. Almost all issues facing our society have at least some relationship to science and research, and decision making by citizens may be improved with a better appreciation for science. For example, a recent decision in Britain calls for conservative members of Parliament to get compulsory lessons in scientific literacy under a plan to strengthen evidence-based policy making (Henderson 2008), and a recent AgBio Forum questioned the role of science in regulation and decision making in the United States (Sundolf 2000). We argue that if scientists value the public's trust and support of science, they must recognize that there is a fundamental need to communicate more with the public (Falchetti, Caravita, and Sperduti 2007). Because of their involvement with science and passion for science, scientists and science educators are in the best position to explain the nature of the scientific process and to advocate for science in order to

increase the public's awareness of the impact of basic scientific research on our daily lives.

With this in mind, we established a semester-long graduate course for future scientists and science educators called Science Outreach—Public Understanding of Science. The course is part of the Science and Me program, which aims to engage science students with the community. In this course, students prepare 40-minute, lay-language presentations about science-related issues (see Table 1) and present them to adult audiences around the community (Alexander and Abell 2010). The presentations offer basic information that enables the audiences to understand the topic's basic concepts, while emphasizing the role of science in these issues. Students highlight the pivotal and irreplaceable part that science plays in attaining the many advances we enjoy on a daily basis in many areas of our lives. The presentations avoid any political, cultural, or religious agendas and emphasize the dynamic, exciting, and universal nature of science.

Venues

We target senior adults in the community. We emphasize reaching adults who otherwise would not attend presentations of this kind, either because they are place bound or because they are not in the habit of seeking presentations about science. As citizens, this group makes important decisions about many issues that are science related, and it is important to reach these groups and to share our knowledge and endeavors with them. However, there are few opportunities for this age group to communicate with scientists or to participate in events that are geared for lay audiences (van der Sanden and Meijman 2008). In this interactive program, we give audience members opportunities to ask question; share their concerns, stories, and life experiences; and communicate directly with scientists.

The course

Graduate students who take the course come from various different academic departments and have widely different scientific backgrounds. At the first meeting, students choose their topics and begin to investigate the material and prepare the presentation. A list of suggested topics for presentations is provided, but the students are encouraged to suggest their own topics on the basis of their passion and expertise, as long as they are not directly part of their graduate thesis research (see Table 1). University faculty members, experts in the latest scientific research in the related fields, are asked to mentor the students, both for accuracy of the presentation as well as for guidance in preparing and delivering the presentations. This has proven to be crucial to the preparation of the presentations and the success of the program.

Organizationally, the course is divided into three parts: Part 1 (weeks 1–4) is devoted to choosing topics and mentors, building the presentations, and holding class discussions on related issues; Part 2 (weeks 5–10) is devoted to delivering the presentations to the class and analyzing their effectiveness; and Part 3 (weeks 11–15) is devoted to delivering the presentations to audiences in their venues and analyzing the experience to improve the presentations.

Part 1

During weeks 1–4, discussions concentrate on the goals of science outreach (Brown, Propst, and Woolley 2004; Burns, O'Connor, and Stocklmayer 2003), the motivation behind science outreach (Martín-Sempere, Garzón-García and Rey-Rocha 2008), the different goals and approaches to a presentation (reading *Persuasive Message: The Process of Influence;* Benoit and Benoit 2008), interaction with the elderly, and technical aspects about preparing the presentation.

Early in the course, the instructor presents a sample presentation and facilitates a feedback session. Throughout the course, after each presentation, each member of the class is expected to point out several elements of the talk that he or she liked and appreciated. Following this praise, each member of the class comments on points in need of improvement. The discussions are aimed at assessing the efficacy, clarity, interest, and impact of the talk in a positive, constructive manner, which allows the speakers to improve their presentations. Using this format, the analysis of the instructor's presentation serves as a basis for assembling a guideline for an effective presentation, to be used by the students while they develop their own presentations.

Part 2

During weeks 5–10, students deliver their presentations to the class, and each presentation is analyzed as described previously. The presenting students also lead a class discussion about misconceptions that they anticipate the public holds with regard to their topic and how to address those misconceptions.

Each student prepares a one-page, colorful, trifold brochure that depicts the main points of the talk and provides further resources for people who seek more information. The brochures are handed out at the end of the talks and are a very popular, well-received feature of the program. Often members of the audience ask for several brochures to be shared with friends or family members.

Part 3

During weeks 11–15, when ready, the students begin delivering the presentations in venues around the community. Presentation reports are submitted by the students after each visit, and the students share their experiences, impressions, and challenges with the class. At the first presentation, each student is accompanied by another class member who comes as a "visiting friend" to offer both support for the speaker and another viewpoint

TABLE 1

Science and Me program—interdisciplinary participation of students and mentors.

Presentation topic	Student's department	Mentor's department
Development and cancer—*When the body does not play by the rules*	Molecular Microbiology & Immunology	Division of Biological Sciences
The secrets behind the sound of music—*Science, symphonies, and synthesizers*	Geological Science	Music
Obesity, diabetes, and sleep loss—*Do we "gain" by losing sleep?*	Geological Science	Neurology
It's getting hot in here: *What's the big deal about climate change?*	Division of Biological Sciences	Forestry
My family's genes—*Do I have to be a chip off the old block?*	Division of Biological Sciences	Biochemistry
The aging brain—*What to remember about memory loss*	Neurosciences/Biomedical Sciences	Division of Biological Sciences
Land-use effects on biodiversity—*How can my golf game help frogs and salamanders?*	Division of Biological Sciences	Division of Biological Sciences
Critters in my backyard—*Why do they keep eating my flowers?*	Fisheries and Wildlife	Division of Biological Sciences
The ever changing flu virus and elephants with short tusks: What do they have in common?—*Why is it so hard to guess the correct flu vaccine?*	Division of Biological Sciences	Division of Biological Sciences
Think green—*Having your vaccine and eating it too?*	Division of Biological Sciences	Biochemistry
Allergies—*What are we sneezing at?*	Division of Biological Sciences	Molecular Microbiology & Immunology; Otolaryngology
Estrogens in our food—*How should I store my family's food?*	Animal Sciences	Animal Sciences
Genetically modified food—*What's on your dinner plate?*	Plant, Insect, & Microbial Science	Division of Biological Sciences

for analyzing the experience. The instructor accompanies each student to one of the presentations.

Even though significant class time is dedicated to the analysis and improvement of the students' presentations and identifying elements of a good presentation and a successful delivery, the biggest impact is achieved during the presentations themselves. The students encounter audiences from a different age group, with varying levels of education and varying levels of trust in science or misconceptions about science; quite often, these experiences result in rewriting portions of the presentations and adjusting the delivery.

One of the goals of the program is to generate a bank of presentations that can be taken to different communities around the state. This implies that the presentations must be available in an easily comprehensible form to other individuals who wish to deliver them. To this end, while preparing their own presentations, students are asked to generate an instructional manual and a cover document. The cover document discusses the general goals students want to achieve by the presentation, the approach chosen to present the topic, anticipated audience questions, anticipated misconceptions, and a list of resources used for preparing the presentation. The detailed instructional manual gives specific instructions for each slide in the presentation.

On the basis of these instructional materials, students—during the third part of the course—deliver each other's presentations to the class. The presenting student is expected to comment on the adequacy of the instructional manual, whereas the class as a whole has a chance to revisit the presentations after they have been improved by the original class discussion as well as the experiences in the field. Presenting another student's talk provides practice of valuable teaching skills, as we often need to teach and present material with which we are

The geologic timescale—*Where do we fit in?*	Geological Science	Geological Science
Infectious diseases—*Can I catch my dog's cold or the bird's flu?*	Science Education	Veterinary Diagnostic Laboratory
The eye, the light, and the lens—*Why is it getting harder to see as I get older?*	Curriculum and Instruction	Science Education
MOVE more and SIT Less!—*The health benefits of putting our socks on.*	Biomedical Sciences	Physical Medicine and Rehabilitation
Sugar: The good, the bad, and the alternatives—*The bitter side of our sweet tooth.*	Division of Biological Sciences	Nutrition
Naked and hungry—*Where would we be without science in agriculture?*	Animal Sciences	Animal Sciences
Aid for AIDS—*Will there be a cure?*	Molecular Microbiology & Immunology	Molecular Microbiology & Immunology
Osteoporosis as a childhood disease—*Health habits kids have can "make" or "break" it, literally.*	Animal Sciences	Biochemistry and Child Health/Physical Medicine and Rehabilitation
What is the need to study a weed?—*Why scientists study simple organisms.*	Division of Biological Sciences	Division of Biological Sciences
Life is a balancing act—*What does science tell us about falling down?*	Division of Biological Sciences	Elm Street Yoga
Facts about fat—*Are some fats good for us?*	Animal Sciences	Nutritional Sciences
An aspirin a day keeps what away?—*How common pain relievers affect our body.*	Animal Sciences	Neurology/Neurological Surgery
The dirt on dirt—*Can we protect soil quality while producing enough food?*	Division of Biological Sciences	Soil, Environmental, and Atmospheric Science
The physics of flushing—*How science is improving the most commonly used seat in our house*	Division of Biological Sciences	Biological Engineering

not optimally familiar. Moreover, this exercise contributes a great deal to the quality of the presentations, because it forces students to define and focus their approach and to set clear goals for the talk in general and for each slide in particular.

Outreach events

Over the past two years, students gave 62 presentations and spoke to nearly 1,000 adults in several independent living facilities in our town, at the public library, and during the yearly reunion of our university's Alumni Association. In addition, each student aired a five-minute session on a local daily television show, which reaches many adults who are at home during the morning hours. Our future plans include a biweekly segment on a public broadcast radio station.

Challenges

We believe the course has exceeded its goals for both the students and audiences. Nevertheless, we have encountered a number of challenges, which we present here to support others interested in attempting such a program.

Audience

A substantial challenge lies in the fact that our audiences are heterogeneous. They vary in their levels of education (from elementary school graduates to retired professors), their personal set of social values, their religious background, and their beliefs (Benoit and Benoit 2008). Mindful of this, students make an effort not to be judgmental or provocative, to present scientific endeavors and the scientific process in a neutral way, to make the topic relevant to the audience members, and—most important—to engage the audience as much as possible in the conversation.

Topics

In senior citizen facilities, we had bigger crowds when the topic was connected to audience members' daily

lives, such as vision loss and memory loss. Members of the audience like to share their experiences and stories when they can identify with the material. However, other topics also drew crowds and interested reactions. Students made an effort to make each presentation and topic relevant to the audience members' lives and daily experience. For example, in a talk about inherited traits (nature vs. nurture), the student personalized the topic by urging the participants to generate their own family tree of traits and diseases so they could help their children and grandchildren make lifestyle decisions that might affect their well-being.

Language

The most challenging part for students is to avoid using professional terms and language, opting for everyday language whenever possible. A lot has been written before about the language barrier facing scientists who are willing to approach the public (Brady and Kumar 2000; Leggett and Finlay 2001), and our experience in this course reinforces this notion. Students often are not aware of how attached they are to the language and jargon of their particular discipline. Making the language accessible to a lay audience, while keeping it intelligent and interesting, requires a lot of effort. For example, students tend to begin the presentation with vocabulary and definitions. We encouraged students to start instead with a life phenomenon, and—when necessary—to use carefully explained terms and definition after the phenomenon had been described.

Message

A great deal of discussion in the course is devoted to the message itself. The goal of each presenter is to bring basic explanations and information about the topics to the audience. However, it is vital to address a broader goal—to depict the role of science in the chosen topic and to highlight advances, setbacks, and the disciplines of science that contributed to this topic, and what and how much basic curiosity-driven research is behind the issue. This is harder than merely explaining a particular topic, and in class discussions we have to continually push this point, asking each speaker: Why is it science? What has science done for me in this area?

Impact

This course was not initiated as a controlled study of the public's understanding of science. With two years of success behind us, we are now designing careful pre- and post-surveys that will enable us to give a quantitative, statistically significant evaluation of the impact of the course. As of now, we rely on students' presentation reports, students' end-of-course evaluations, and responses from audience members and activity coordinators in the different facilities. These responses (see Appendix) show that both students and audience members have benefitted from the course and recommend the program to others.

Faculty support

With the increasing demand for "broader impact" being requested by funding agencies, many departments and faculty members support the course and its efforts. We do, however, encounter faculty members who do not support our notion of the importance of outreach and actively discouraged their students from diverting time and resources to this course. In research labs in which students are paid out of government-funded research grants, expenses for students' tuition have to be itemized when grant proposals are submitted. Thus, several grant-funded researchers had difficulties diverting money toward tuition for this course. To address these concerns, we are working to cross-list the course with other departments and to secure some funding for students' tuition when this is an issue. We continue to hope that the positive feedback we get from the community, and the positive experience that the students have, will eventually help the course reach its "tipping point."

Summary

Many graduate students in science and in science education will find themselves teaching science, whether full-time or as part of their future faculty positions. This course teaches students to generate a compelling, interesting, and understandable presentation. The analysis of each talk in class, the feedback from class and faculty members, and—most important—the response of the audiences to the talks help students focus on the message and achieve a clear and interesting delivery. Students stated that they believe they acquired skills that they will use in their future careers. Hopefully the positive and heartwarming responses from audience members will encourage students to continue to engage in similar endeavors and to make outreach part of their mission in their future careers.

Increasingly, granting agencies today require scientists to show a broader impact of their work and a connection to the community. In this regard, this course makes several contributions. For students who participate in the course, this is a significant addition to their "outreach resume." As mentioned above, students are paired with faculty mentors from the relevant disciplines. Over the past two years, we engaged 19 faculty mentors from 10 different departments (see Table 1), thus making this course an interdisciplinary effort while providing outreach opportunities for faculty members as well.

Last, there is the community benefit. It is hard to assess the success of this program in a quantitative manner. Some of the audience members we encountered have had little formal education and no past experience listening to science-related talks, and we feel that having to assess the presentation, either through conversation or in

writing, would be threatening and deter some of them from coming back. We do gather students' evaluations of their interactions (through the presentation reports), we communicate with activity directors at the different venues, and we gather anecdotal responses from residents (see Appendix). From all of these, we learned that the intergenerational aspect of the program is very special to both students and audiences. Students enjoy their interactions with audiences in the senior living facilities and feel that they are contributing to the community, and to science, in significant ways. For example, one of our students gave a talk called "Estrogens in our food—How should I store my family's food?" which was about xenoestrogens and their mode of action, and what BPA (bis-phenol-A) is and its presence in plastic baby bottles. During the talk, the student and the audience had a conversation about how important it is to understand that science is dynamic and constantly re-examines its conclusion, which in this case means reevaluating the use of a chemical that was considered a wonder just a few decades ago. Two days later, the local paper in our community ran a front-page story about BPA and new efforts by the FDA to reexamine its recommendations for allowable dosage. Because of the talk, there was one group of citizens in the community who—when reading the article—had a notion about what BPA is, how it works, and where it can be found.

The students are usually well received by the audiences, and all the venues we visited in the first year invited us back for the entire series in the following years. Audiences, especially in independent living facilities, are touched by the fact that the "young scientists" come to deliver the presentations and readily interact with the students before, during, and after the presentation. As one 92-year-old member of the audience summed it up for us: "The students remind me that one is never too old to learn." For his part, he and his peers have demonstrated to us that there is an audience out there that we need to continue to reach and that people are indeed curious and want to know more about the development of scientific knowledge and the advances that come from it. ■

Note: Since submission of this article, we have completed a third year of the program and enjoyed continued growth. To date, students have given 103 presentations, expanded the list of venues, and interacted with a total of 29 faculty mentors. For more information, visit *www.scienceandme.org*.

Acknowledgment

We thank Dr. Stephen Alexander for help preparing this manuscript. Our deepest thanks to the students and postdoctoral fellows who participated in the course over the past three years and contributed to the success of the program.

Dedication

This work is dedicated with love to the memory of Sandi Abell, a dear friend and a giant in the field of science education.

References

Alexander, H., and S. Abell. 2010. Science and me: Intergenerational interaction rewards both sides. *Journal of Intergenerational Relationships* 8 (1): 79–82.

Benoit, W.L., and P.J. Benoit. 2008. *Persuasive message: The process of influence*. Malden, MA: Wiley-Blackwell.

Brady, I., and A. Kumar. 2000. Some thoughts on sharing science. *Science Education* 84 (4): 507–523.

Brown, C.P., S.M. Propst, and M. Woolley. 2004. Report: Helping researchers make the case for science. *Science Communication* 25 (3): 294–303.

Burns, T.W., D.J. O'Connor, and S.M. Stocklmayer. 2003. Science communication: A contemporary definition. *Public Understanding of Science* 12 (4): 183–202.

Falchetti, E., S. Caravita, and A. Sperduti. 2007. What do laypersons want to know from scientists? An analysis of a dialogue between scientists and laypersons on the website Scienzaonline. *Public Understanding of Science* (16): 489–506.

Henderson, M. 2008. Conservative MPs will be forced to keep up with science (Editorial). *The Sunday Times*, November 18. *www.times online.co.uk/tol/news/science/article 5168006.ece*

Leggett, M., and M. Finlay. 2001. Science, story, and image: A new approach to crossing the communication barrier posed by scientific jargon. *Public Understanding of Science* 10 (2): 157–171.

Martín-Sempere, M.J., B. Garzón-García, and J. Rey-Rocha. 2008. Scientists' motivation to communicate science and technology to the public: Surveying participants at the Madrid Science Fair. *Public Understanding of Science* 17: 349–367.

Miller, J.D. 2004. Public understanding of, and attitudes toward, scientific research: What we know and what we need to know. *Public Understanding of Science* 13 (3): 273–292.

Sundolf, S. 2000. The role of science in regulation and decision making. *AgBioForum* 3: 137–140.

van der Sanden, M.C.A., and F.J. Meijman. 2008. Dialogue guides awareness and understanding of science: An essay on different goals of dialogue leading to different science communication approaches. *Public Understanding of Science* 17 (1): 89–103.

Hannah Alexander (alexanderh@missouri.edu) *is an adjunct associate professor in the Division of Biological Sciences and* ***Anna M. Waldron*** *is the director of the Office of Science Outreach, both at the University of Missouri in Columbia.* ***Sandra K. Abell*** *was a Curators Professor and director of the Science Education Center at the University of Missouri until her untimely death in August 2010.*

Appendix

Comments from students, audience members, and facility managers

Comments from students about the course

"The overall goal of the course was excellent. I thought that the general approach of developing and practicing the presentations in class before going out to the public venues was effective and worthwhile."

"The basic structure of the course is great. Constructive criticism sessions were very good. The goals of the course are laudable. I hope a certificate program (or a rough equivalent) on public understanding of science comes out of it, or that the course becomes included curriculum for existing programs. This was a completely new audience for me, and a necessary developmental step. Thanks!"

"I thought that the lessons in communication were really great. Get to know you audience, keep things broad and speak simply about complex ideas and topics that the audience is intelligent enough to understand. The lessons in creating simple, easy-to-read prospectus and handouts were also useful. I loved going out to these retirement communities that were eager to learn—it was fun! I also loved hearing about the other topics discussed in class, especially since we had such a diverse group of students. The instructor comments were always helpful and encouraging. My own presentation changed from the first time I gave it in class. I got a lot of good comments and questions that made me add slides to clarify certain points."

Students' comments about interaction with the audience

"For me, interacting with these adult audiences (1) provided me with a new perspective about the topic, (2) helped me identify/acknowledge where the 'holes' are in science, and (3) showed me how interested these adult audiences are in learning. I think we all learned that we shouldn't prejudge or stereotype people when it comes to outreach."

"It was amazing to me how my topic piqued the interest of so many people. One of the most fulfilling aspects of this experience was the discussion period following the presentation. It often lasted longer than the presentation itself and included many personal anecdotes."

"One real challenge was to balance background information (e.g., define biodiversity) with examples of contemporary science, relevant to the audiences. Connecting with the audience and speaking to their experiences is very important."

"Many of the elderly groups we talked to expressed interest in sharing information with their friends who couldn't attend the seminars and even requested additional handouts."

"The turnout was great, and the audiences seemed attentive and interested, responding to my questions and asking many of their own. Their understanding level seemed good as well, and at least they understood enough to ask some good questions. One of the residents told me afterwards that the pace/complexity was appropriate for the audience. I really enjoyed it, and I think we should definitely go back there in the future."

Comments from audiences

After presentation at the public library, an audience member: "I heard the presentation about eyes at the library. This is just too good for others not to attend. Are there other similar programs being presented? I belong to a ladies group interested in educational program of about 20 minutes."

A resident: "I am 92 years old, and today you reminded me that you are never too old to learn."

After presentations about the brain and memory loss to alumni at the annual alumni reunion: "Thank you for the interesting and highly informative presentation that you made at our 50th class reunion on Monday. It was obvious that you enjoy the subject area and know a great deal about it. More important to me, you presented the material in a way that I understood what you were talking about. You are a great teacher and with your natural ability, you can influence a lot of young people at the university. I appreciate the way you handled an aging audience and kept them interested and talking about your presentation for the remainder of the reunion. For many of us, it was one of the high points of the three days. I wish you good fortune in wherever life takes you."

From a student's report: "The residents expressed their appreciation for me stopping by to give them the talk. They really liked it, and one of them even tried to recall one of the "Science and Me" series that they've heard. They commented that I spoke clearly and would be a very good instructor someday. That was encouraging to hear. That means they did retain something. It was a good experience overall."

From a student's report after a genetics talk: "They asked about stem cells and also if we can correct genes in vivo. They asked about sex-linked traits a lot as well. They told me they liked the talk and would love more of them."

Comments from facility managers

Activity director in independent living facility: "Thank you and your students so very much for the programs! I have heard wonderful comments from the residents and even a few as to whether or not you would be doing this again next year. They will be happy to know that you will be!"

Manager, Reference and Information Services, Regional Library: "Thank you again for arranging for the two great science programs at the library this month. We really appreciated having this opportunity! Are you interested in doing anything this spring?"

Activity director at an independent living facility: "Those lectures were great! I know that the turn out is always good, so it'd be great to have the students come back. If you could give me contact info for them, I can get in touch and schedule something. Much appreciation."

Activity coordinator in an independent living facility: "Residents look forward to the information, are eager listeners, and enjoy the question-and-answer period with the presenters. The residents take delight in asking enough in-depth questions to the point that the presenter's knowledge is exhausted, and he or she must defer to further research before knowing the answer. I look forward to the presentations because I know that the presentation will contain usable information and will be enjoyed by the residents. Also, the presenters will be prompt, courteous, and effective orators. It is a wonderful program to include in the Terrace activities."

Activity director at independent living facility: "I know that the residents that have come have enjoyed the experience. On their behalf we would invite you back again."