A Novel Lecture Series and Associated Outreach Program in the Environmental and Natural Sciences

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We describe the creation and development of a multidisciplinary outreach effort from the university science community to the general public and K–12 teacher and student audiences.

Most university scientists recognize the importance of reaching out to explain their science to the public and the K–12 community. They enjoy explaining their discoveries to the public, and understand the importance of making clear the relevance of their research to the public and the role it can play in engaging K–12 students in considering science as a career. More recent motivation comes from agencies such as the National Science Foundation, which now requires a "Broader Impacts" component in each research proposal that they consider for funding. In spite of these driving factors, public and K–12 outreach are often relegated to a low priority at universities because they are generally not among the factors that are considered for promotion and tenure, nor are they part of the academic culture that graduate students are exposed to at major research universities. The need for strong public and K–12 science outreach is underscored by the decreasing interest in science and technology careers among K–12 students and the need to have highly qualified and trained teachers in the classroom (NRC 2006). University outreach can provide science content and skills to teachers who may be new to a subject area, update those who have been teaching for many years and need refreshing, and keep any teacher literate and current on changing topics such as climate change and sustainability. It can also inspire K–12 students who may otherwise not consider science as a career path.

K–12 science outreach programs can take many forms, each with their own advantages for improving the transfer of science research to K–12 classrooms (e.g., Casciato and Greenburg 1976; Blackwell and Durocher 1995; Edgett and Christensen 1996; NSF 1997). Our approach to addressing the low priority given to university-level outreach was to create an outreach program that makes it easy for scientists to connect with the public, while at the same time providing effective transfer of scientific research results to the public and the K–12 community. The result is a program called the Hot Science—Cool Talks Outreach Lecture Series, a regular event at the University of Texas at Austin (UT Austin) overseen by the university's Environmental Science Institute (ESI). The program combines lectures by scientists with hands-on activities, webcasts, and workshops for teachers, students, and the public.

We began the program in November 1999 as a geology lecture series, and we have since expanded it to include a wide variety of natural-science, social-science, and engineering topics, most of which are tied to a central theme of the environment. Three to four lectures are given per academic semester by UT Austin faculty, visiting scholars from other institutions, and professionals from government organizations and public utilities. The lecture topics range from the latest science technology (e.g., space-based observations of the Earth), to the latest scientific theories and research results (e.g., the influence of climate change on species ranges), to basic scientific principles (e.g., the causes of earthquakes).

While the idea of the lecture series alone was worth pursuing, we also wanted to do more than just provide researchers with a forum for speaking to a general audience. In addition to bringing university science to the public, we also sought to focus the program to help K–12 teachers bring new science into the classroom and to motivate students. To achieve this goal, we developed ways to make the events more than just a lecture and to make the lectures more fun and useful. For the presenters, a review committee provides editing assistance to help in making their presentation easier to understand and to enhance its multimedia content. For the teachers, we invest personnel resources to produce CD-ROMs for each lecture that contain all of the lecture materials and additional resources related to the topic including lesson plans, interactive multimedia, and curriculum requirement information. We distribute these free of charge to any K–12 educator who attends the lecture. For students and the general public, we organize interactive activities, including hands-on laboratory tours (e.g., computed x-ray tomography and image analysis lab) and self-guided tour maps of other exhibits around campus. The most extensive activity we organize is a series of hands-on displays related to the speaker's general topic. These displays are set up in the foyer outside of the lecture hall on the evening of the lecture.

Our program has now produced 45 events and expanded to include new technologies such as webcasting. All of the feedback we have received indicates that this type of program is an innovative and functional means to transfer the information from the speakers' research labs to teachers' classrooms. This paper describes the concept for this lecture series, its operation, and its unique outcomes for K–12 outreach.

How the program works

The success of each event depends on both the topic presented and the presenter's ability to connect with a diverse audience. Choosing outstanding speakers for the program is a constant challenge. Programmatic decisions are made by a Hot Science—Cool Talks review committee consisting of a small group of PhD faculty and researchers with input from a graduate student and a multimedia expert who assist with the program. It is essential that the committee review the presentation from both scientifically sophisticated and inexperienced viewpoints. As a presenter's speaking ability greatly influences the success of the event, we research each candidate speaker's skills in this area, evidence for which may include teaching awards, media coverage, and word-of-mouth among university students and faculty colleagues. We make a significant effort to help the speaker choose topics and structure the lecture materials so that the talks are presented at a level appropriate for audiences that may include upper-elementary through high school students, as well as laypersons in the general public. Each presentation, in PowerPoint format, also contains a full set of slide notes written by the presenter and edited by the review committee. We pay particular attention to including definitions for advanced scientific terms within the notes, and we focus our editing on developing a presentation that could be understood without the speaker being present.

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TABLE 1

Results of surveys addressing K–12 teachers' use of the materials on the CD-ROMs and website.

A. How teachers have used the CD-ROMs ($n = 34$).

Reviewed content to increase my knowledge on the subject	85%
Used a portion of the presentation, or images from it, in class for a new lesson/lecture	82%
Used a portion of the presentation, or images from it, in class to augment my existing lesson/lecture	71%
Used lesson plans and related web resources suggested from the CD	44%
Used with individual students based on their interest	38%
Gave the entire presentation to a class	29%
Used the suggested TEKS* associated with the lecture	29%
Used the TAKS** sample questions (new as of October 2005) associated with the lecture	18%
Used to train other teachers	12%

B. Resources related to the presentation teachers have used ($n = 16$).

Presentation in PowerPoint format	94%
Presentation in Adobe PDF format	1%
Image folder with all graphics used in the presentation and CD	44%
Presentation notes	44%

C. What teachers have found useful from the website ($n = 20$).

Archived PowerPoint with notes	65%
Archived video of presentation	60%
Maps and directions	50%
Biographies of presenters	35%

*TEKS: Texas Essential Knowledge and Skills curriculum standards
**TAKS: Texas Assessment of Knowledge and Skills test

The main goals of developing the detailed presentation are to ensure the transfer of this scientific information to the K–12 classroom and to provide engaging materials that teachers will use. We specifically do not try to tailor the content of the lectures to fit specific modules in existing public-school curricula because many speakers would not be able to participate if they were faced with the time commitment of preparing lecture material constrained to meet curriculum requirements. We also feel that the talks should play to the strengths of the speaker so that teachers and others can get closer to the personal excitement of scientific discovery as speakers present their own research. This approach demands that we select speakers who are excellent teachers and who are doing cutting-edge research that is of wide interest to the public.

Informal polling of teachers informed us that approaching the lecture series as an educational evening out would attract the most teachers and students. Lectures are usually scheduled for Friday evenings during the school year with prelecture activities beginning at 5:45 p.m. and the lecture running from 7:00 to 7:50 p.m. A question-and-answer period follows the lecture. These question-and-answer sessions usually run 30 minutes and always have to be cut off by the lecture-series host so as to not overly impose on the speaker's time and energy. Thursday evenings have also been popular and avoid conflicts with Friday night high school football games.

Advertising the program is important for maintaining a large and consistent audience. For each lecture, we design and print over 200 eye-catching posters, which we distribute around the UT Austin campus, to K–12 schools in 10 local school districts, and to other public institutions such as libraries. We also have grown an e-mail newsletter subscription list to over 1,200 people in the local area, and we send announcements to groups around the country to advertise the webcast. For each event we contact local media outlets as well as appropriate public, governmental, and other nonacademic organizations, such as a local stargazing club for talks on astronomy topics.

Materials for teachers

To make our program more than just a nice evening out for teachers, we decided to produce CD-ROMs that contain all of the materials needed to use all or part of the lectures in their own classrooms. We anticipated that this aspect of the program would greatly enhance the knowledge transfer, because after a week of hard work, even the most industrious teacher is unlikely to take diligent notes and then later track down the necessary resources, suitable images, and scientific explanations so that they can present the same material to their students.

For each lecture we print 1,000 CD-ROMs, which we give away at no cost to every K–12 educator who attends. We distribute the CD-ROMs to a wider audience through local, national, and international education conferences. The CD-ROMs contain all of the lecture materials, complete with full slide notes as edited by the speaker and the review committee, so that teachers can use the presentation as a lesson plan or reference for the science topics that were presented. We also include on the CD-ROMs additional information related to the lecture topic, including (1) interactive multimedia, (2) links to useful resources on the web, (3) lesson plans built around a sequence of

slides from the speaker's presentation, and (4) correlations of lecture materials and lesson plans to state curriculum standards (e.g., Texas Essential Knowledge and Skills) listed by grade and subject. In this manner, teachers can quickly decide which materials will be most engaging for their students and will fit best with their teaching plan. The lesson plans (item 3) are the most recent addition to the CD-ROMs. These are 20–45-minute modules and were developed to create a particularly engaging teaching tool because the full presentation by the speaker may be more difficult to incorporate into existing curricula.

The additional materials for the CD-ROM are compiled by the review committee from contributions by upper-division undergraduate students in the UTeach program, members of the review committee, the speaker, and graduate students in the speaker's home department. UTeach students pursue a BS in science or math, along with teacher training, certification, and an education degree option (*https://uteach.utexas.edu/go/uteachweb/Home*). The review committee obtains permission to use materials that have been copyrighted and screens all of the internet resources and links to assure that they are of sufficient quality, something that is often much more difficult and time consuming for teachers to do on their own.

When possible, we try to include interactive multimedia such as (1) a Java program that lets students analyze different types of emissions in a simulated city for a lecture that discussed urban air quality; (2) video of science demonstrations given by the speaker that can easily be done in a classroom; or (3) multimedia that a teacher can use to perform the same activity in their own classroom, such as a PowerPoint slide of a diverse set of frog species sound files for a student activity that illustrates biodiversity and behavior.

Lastly, we put the presentation materials on the CD-ROM in a variety of formats to accommodate different needs, and we design a professional cover for the CD-ROMs. To allow low-cost worldwide distribution, we archive all of the presentations online in a website dedicated to the Hot Science—Cool Talks program (*www.esi.utexas.edu/outreach/lectures.html*). In order to allow for the presentation review process and time for the 1,000 CD-ROMs to be printed by a vendor, we begin the process at least two months before the lecture date. Table 1 gives the results of a survey of teachers that indicates how they have used the materials on the CD-ROM and lecture-series website.

FIGURE 1

K–12 students engaging in a prelecture activity for the Hot Science–Cool Talks lecture "Brave New Ocean." This lecture discussed the decline of the world's oceans and the multiple, synergistic threats to their sustainability. The hands-on activity shown involves examination of live and fossil marine biota.

Scientist-teacher interactions and prelecture activities

We have found that scientists who would not normally get involved in outreach are more likely to participate in our program because of the number of people we reach compared with standard outreach activities such as classroom visits. With one lecture, a speaker can reach over 400 people in our program compared to 25–30 people with a single classroom visit. Table 2 provides attendance information for the 2005 and 2006 Hot Science—Cool Talks lectures.

For each event, we organize refreshments and 1.25 hours of prelecture activities that have included a range of activities and demonstrations for both students and adults. These additional efforts encourage interaction among the speakers, the public, teachers, faculty, and K–12, graduate, and undergraduate students attending the event. These activities transform the event into an evening activity rather than just a talk. The prelecture activities are organized by the review committee to relate to the topic of the talk, but they are put together and presented by a wide range of contributors, including graduate-student and faculty researchers from the speaker's department, undergraduate research clubs, and members of local government and nonprofit organizations

TABLE 2

Hot Science—Cool Talks lecture attendance and website visits, 2005–2006.

Topic	Speaker and affiliation*	Date	Attendance			Webcast viewers		Website visits**
			Total	Teachers	Students	Live	Archive	
The History and Future of Whales	Dr. Stephen R. Palumbi Stanford University's Hopkins Marine Station	11/16/06	563	35	44	57	521	919
Is Climate Change Increasing Hurricane Activity?	Dr. Kerry A. Emanuel Massachusetts Institute of Technology	10/05/06	589	68	69	123	542	1,210
Race for a Cure	Dr. David M. Oshinsky	9/07/06	288	37	88	59	209	684
Fighting Deadly Diseases	Dr. Lauren Ancel Meyers	4/7/06	420	50	66	93	567	1,771
Brave New Ocean	Dr. Jeremy Jackson Scripps Institute of Oceanography	3/3/06	552	57	46	121	1,056	2,870
To Infinity and Beyond	Dr. Michael Starbird	2/2/06	440	35	89	160	918	1,275
The Striking Behavior of Rattlesnakes	Dr. Travis LaDuc	11/18/05	480	33	46	119	786	2,049
The 2004 Mars Exploration Rover Mission: Evidence for Water and Prospects for Life	Dr. John Grotzinger California Institute of Technology	10/13/05	500	26	59	361	1,925	12,286
Dinosaurs in the Digital Age: Facts, Fictions, and Forgeries	Dr. Timothy Rowe	9/9/05	480	33	91	99	874	2,595
Ice Adventures: Tracking Evidence of Abrupt Climate Change Across the Tropics	Dr. Lonnie Thompson The Ohio State University	4/15/05	292	26	56	39	880	3,280
CSI–Texas: The Science of Sleuthing	William L. Ginn Texas Department of Public Safety	3/11/05	450	43	112	70	797	4,307
Science and the Movies: The Science Behind Stunts and Special Effects	Steven Wolf Science and the Movies	2/4/05	450	49	48	65	694	3,381

* Speaker affiliation only given if other than UT Austin.
** Website visits for a given lecture include visits to the archived webcast or the archived PowerPoint presentation.

from outside the university. Teachers pick up their CD-ROM of that evening's lecture while attending these activities.

Prelecture activities have ranged from tabletop demonstrations and hands-on activities with live specimens (e.g., Figure 1) to short lab tours and working demonstrations of technology and equipment around the university. For example, before the lecture "Studying the Earth From Manned Spacecraft," volunteers took small groups from the prelecture reception to view the Department of Geological Sciences' new wall-sized poster of the plate-tectonic map of the world, short computer animations of plate-margin processes, and a live demonstration of the use of Global Positioning System equipment. Before another lecture, "CSI–Texas: The Science of Sleuthing," the Austin Crime Scene Investigation Unit brought in police dogs and demonstrated the use of lifesaving equipment. Prior to the lecture "Is Climate Change Increasing Hurricane Activity?" students from a UT Austin introductory undergraduate course on sustainability presented a fish-tank scale model of the greenhouse effect, in which attendees observed firsthand the increase in air temperature when CO_2 was introduced into the tank (Lueddecke, Pinter, and McManus 2001).

These events get teachers, students, and other members of the community more involved and make faculty more accessible. A continuity of interaction between K–12 teachers and UT Austin faculty has developed, and the events have generated much interest amongst our faculty in terms of participating in the receptions, assisting with laboratory tours, and setting up hands-on displays of their research and collections. The prelecture activities have been popular with the K–12 community, and many teachers have come to the lectures with their class or their school's science club. Many teachers also offer students extra credit for attending the lectures and writing summaries of the lectures and prelecture activities. Interestingly, our initial connection with the K–12 community was primarily through individual teachers and word-of-mouth. With time, we established relationships with local

school-district administrations, which has helped in broadcasting news of our series.

Webcasting

We began webcasting our Hot Science—Cool Talks series in 2001. With the rapid pace of technological development in this area, we have changed our webcasting system several times in order to take advantage of new hardware and software capabilities. Our most recent system provides windows for the projected slide and a video of the presenter (Figure 2), which requires that we have a manned video camera to film the presenter during the talk. We also include a feature on the website that allows remote viewers to write in questions for the presenter, which are asked by the lecture-series host during the question-and-answer session at the end of the talk. The entire event is broadcast live and is archived on the lecture-series website as soon as the event is over. Chapters are added to the archived presentation so that viewers can go directly to any part of the talk (Figure 2).

Our webcasts have been technologically successful, but have required considerable experimentation and collaboration with technology providers around campus. We encourage early conversations with campus technology staff for anyone contemplating webcasting. The archived webcasts have received an average of more than 800 hits per lecture (Table 2), but developing a significant live audience for the webcasts remains a challenge. Our most successful webcast to date was for a 2005 lecture about the Mars Rover Mission. After advertising the event on numerous space-related websites, 361 unique live viewers attended remotely, including viewers from Canada, Greece, and Australia. This lecture alone has generated over 12,000 hits to our website. The large number of website visits for essentially all lecture topics (Table 2) suggests that many website visitors, while likely attracted to visit the site for a specific topic, explore many other topics once they arrive at the site.

FIGURE 2

The interface for the Hot Science—Cool Talks webcast. The three windows show (clockwise, upper left to lower left) the live streaming video and audio of the speaker, the PowerPoint slide being shown by the speaker, and the index of the presentation topics. There is also a feature on the lecture-series website that allows webcast viewers to submit questions for the presenter that are asked during the question-and-answer period at the end of the lecture.

Connections with other outreach programs

The ESI directs a successful Graduate Teaching Fellows in K–12 Education (GK–12) program funded by the National Science Foundation. The GK–12 program provides fellowships for graduate students in the sciences to work for 15 hours per week with science teachers in local K–12 classrooms. GK–12 fellows organize teacher workshops around science topics from concurrent events in the Hot Science—Cool Talks program. The workshops are available to teachers in and outside of the GK–12 program, and they provide teachers with the opportunity to participate in a more detailed investigation of the science topics from the lecture to learn about the material in both field and classroom settings with scientists. In addition, to go along with the field workshops, the graduate students prepare packets for the teachers that contain all the material and information they would need to take their own classes on the same field trip. Examples include field workshops in the Llano and Austin areas following lectures on "Geologic Wonders of Central Texas;" "The Edwards Aquifer: Will There Be Water for Texas?"; and "The Good, the Bad, and the Ugly: Texas's Amazing Insects." For each field workshop, two to four faculty and researchers have participated from different but related fields, such as geologists, urban planners, and biologists on "The Edwards Aquifer" workshop. These workshops have been popular with K–12 teachers, and we

TABLE 3

Results of audience demographic surveys.

Demographic categories	October 5, 2006 (n = 250*)	November 16, 2006 (n = 216*)
K–12 community	48%	43%
K–12 students	24%	28%
Elementary school student	2%	4%
Middle school student	10%	5%
High school student	12%	19%
K–12 teachers	16%	9%
Elementary school teacher	4%	2%
Middle school teacher	8%	3%
High school teacher	4%	4%
Parent of K–12 student	8%	6%
University community	40%	47%
Undergraduate student	27%	40%
Graduate student	5%	2%
UT Austin faculty and staff	6%	5%
Non-UT faculty member	2%	0%
General public	11%	10%

* Total audience size given in Table 2.

have repeated some in consecutive years.

Response to and impact of the program

Based on the response of the teachers and the general public, the Hot Science—Cool Talks program has been successful. Typical attendance for the lectures over the seven years of the series is 300–400 people, and several lectures brought overflow crowds of more than 600 people. K–12 students and teachers from more than 50 schools, plus various home schools, have attended the Hot Science—Cool Talks lectures. In addition, faculty and students from more than 15 different academic departments at the university, as well as individuals from several other academic institutions and the general public, have attended. Our e-newsletter includes teachers from more than 10 regional school districts, individuals from government and nonprofit institutions (e.g., Texas Department of Parks and Wildlife, the U.S. Geological Survey, and regional water authorities), and the public.

Teachers in particular have responded positively to our program, as measured by their continued attendance and their response to surveys. In 2006, the average audience size was 475, of which 10% were teachers and 14% were K–12 students, based on student and teacher sign-in sheets used during the prelecture activities (Table 2). Results of general audience survey cards handed out during the lecture suggest that the percentage of K–12 teachers and students is even higher: 13% and 26%, respectively (Table 3). These differences are likely the result of less-than-complete participation by the attendees in both the sign-in and the survey. With the inclusion of parents of K–12 students attending the lecture, the K–12 community makes up nearly half of the audience (Table 3). Several teachers have attended nearly all of the lectures. One teacher from Jefferson, Texas, a five-hour drive from Austin, has traveled to multiple lectures. Due to the benefits that teachers receive by attending these outreach events, local school districts offer professional development credit to teachers attending the lecture series.

We have used ongoing teacher and student surveys to find out what they like best about the Hot Science—Cool Talks program, how they think the program could be improved, what topics they would like to see presented in future lectures, and if and how teachers use the resources that we distribute on CD-ROM. The results indicate more than 90% of the teachers have used some of the resources either in their classroom or for preparation. Teachers have reported using the CD-ROMs in many different ways, including to increase their content knowledge, to give the presentation to their class, and to use lesson plans and related web resources suggested from the CD-ROM (Table 1). Of teachers who reported

TABLE 4

Annual budget for Hot Science—Cool Talks.

Staff	
Research staff for presentation review and program coordination	$44,560
Administrative staff	$11,056
Multimedia staff	$17,240
Student assistants	$6,000
Materials	
CD printing and packaging, advertising, refreshments	$11,680
Total	$90,536

not having used the CD-ROMs, most of them had only attended one or two lectures. Although university professors were not the intended audience, many of them have reported using the CD-ROMs in their classes as well.

The local media have covered the Hot Science—Cool Talks concept at the start of the series and have occasionally run features on particular lectures. Austin's only local daily newspaper has run several short articles on lecture topics. The local NBC-TV and ABC-TV and National Public Radio affiliates have run short segments, some including an interview with the upcoming speaker and images from the CD-ROM.

Costs and institutional requirements for the program

While we receive quite a bit of volunteer help from students and faculty at the university, this program would be impossible to provide without funding. Table 4 lists the annual budget for the Hot Science—Cool Talks program. Per-lecture costs are currently $15,000. More than 80% of this total represents salaries for a half-time graduate research assistant or program coordinator to organize the program; a half-time multimedia specialist for creating and compiling the presentation, website, and advertising materials; and portions of administrative salaries for other staff. CD-ROM reproduction and packaging costs are approximately $1.20 each in lots of 1,000.

Options for making the program more affordable

Although this program has developed at a large university with substantial resources, we believe this type of program could be modified to work at many academic institutions. We consider here possible ways that the core features might be replicated at a lower cost. The start-up of new or smaller-scale programs of this type could be facilitated by initially forgoing webcasting, and by using in-house production of fewer CD-ROMs. Several lectures and their supplementary materials could be placed on a single disk. Distribution of lecture materials by posting them for downloading from a website could eliminate CD-ROM duplication costs entirely, as well as personnel time to distribute the CD-ROMs. To reduce the burden of personnel costs, a new program could work to enlist greater input from the speakers, employ additional volunteers such as students from the speaker's cadre of graduate students, or make the production of the series the main product of a graduate class in science education. Cultivating relationships with both teachers and administrators may help assure quick growth in lecture attendance.

The program was started with a commitment of funds by the dean of the College of Natural Sciences and the chair of the Department of Geological Sciences to produce the first five sets of CD-ROMs, and a voluntary commitment of faculty and student time. Since that time, the program has been funded and expanded by the ESI, which in turn receives funding for this program from UT Austin's administration, including the Office of the Provost, the College of Natural Sciences, and the Jackson School of Geosciences. The ESI has received some support from corporate foundations for the lecture series and continues to explore nonuniversity sources of funding. We envision that the Hot Science—Cool Talks program can provide a model for other academic institutions to implement similar outreach programs. ■

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