The Virtual Scientist: connecting university scientists to the K–12 classroom through videoconferencing

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McCombs GB, Ufnar JA, Shepherd VL. The Virtual Scientist: connecting university scientists to the K–12 classroom through videoconferencing. Adv Physiol Educ 31: 62–66, 2007; doi:10.1152/advan.00006.2006.—The Vanderbilt University Center for Science Outreach (CSO) connects university scientists to the K–12 community to enhance and improve science education. The Virtual Scientist program utilizes interactive videoconference (IVC) to facilitate this connection, providing 40–50 sessions per academic year to a national audience. Scientists, defined as research faculty members, clinicians, postdoctoral fellows, graduate and medical students, and professional staff, participate through conventional volunteer recruitment and program announcements as well as outreach partnership efforts with other Vanderbilt centers. These experts present 30- to 45-min long, grade-appropriate content sessions from the CSO IVC studio or their own laboratory. Teachers register for sessions via an on-line application process. After the session, teachers, students, and experts are requested to complete an anonymous on-line evaluation that addresses both technical- and content-associated issues. Results from 2003 to the present indicated a favorable assessment for a promising program. Results showed that 69% of students (n = 335) and 88% of teachers (n = 111) felt that IVC improved access to scientists, whereas 97% of students (n = 382) and teachers (n = 126) and 100% of scientists (n = 23) indicated that they would participate in future videoconferences. Students and teachers considered that the Virtual Scientist program was effective [76% (n = 381) and 89% (n = 127), respectively]. In addition, experts supported IVC as effective in teaching [87% (n = 231)]. Because of the favorable responses from experts, teachers, and students, the CSO will continue to implement IVC as a tool to foster interactions of scientists with K–12 classrooms.

interactive videoconference; science education; distance learning

Higher education institutions are escalating efforts to work with K–12 schools to expand, improve, and supplement educational efforts (4). Nowhere is the need more evident than in the sciences (9). University and K–12 partnerships abound in areas such as teacher professional development and student enrichment programs. Central to this effort is the participation of those trained in science: scientists. However, a logistical problem ensues when university faculty members and research scientist appointments emphasize primary responsibilities in research, clinical practice, and teaching, whereas national funding agencies such as the National Institutes of Health (NIH) and National Science Foundation are requiring more outreach components in their proposal requests.

The Vanderbilt Center for Science Outreach (CSO) has as its core mission a commitment to improving K–12 science education by connecting the university scientist to the K–12 arena (12). The CSO provides several established programs, both locally and nationally, that promote expansion and refinement of the K–12 science curriculum with the involvement of university faculty members, research scientists, clinicians, postdoctoral fellows, and graduate and medical students. These programs include formal in-classroom partnerships between teachers and scientists in training, teacher professional development workshops, development and dissemination of hands-on science kits for classroom use, summer science camps, and multimedia communication of science through the production of interactive CDs, web content, and a national “Virtual Scientist in the Classroom” videoconferencing series.

Two-way interactive videoconference (IVC) provides a convenient and effective method for the university scientist community to educate K–12 students and teachers in science classrooms locally and across the country (6). IVC allows a two-way audio and video connection such that participants can communicate between sites. State universities and community colleges have taken full advantage of this medium to deliver courses from the main campus to extension campuses. School districts disseminate traditional and elective courses between high schools where instructors may be limited. Many higher education institutions offer dual-credit courses (both high school and college credit) via IVC at reduced tuition to districts attempting to serve advanced high school students. With shrinking field trip budgets, museums, science centers, and zoos are providing enrichment opportunities to K–12 classrooms, libraries, and community centers through IVC. The Virtual Scientist program creates a formal bridge between the science expert and teacher/student audience while promoting an informal interaction open to discussion and exchange. Teachers can select topics suitable to their content needs, with a reasonable time commitment required of the scientist.

The Virtual Scientist program was initiated as part of a NIH-funded Science Education Partnership Award (1999–2004) devoted to improving technology use in science education primarily for Metropolitan Nashville Public Schools. The program successfully infused technology into the middle and high school science classroom through the development of instructional biomedical CDs, teacher professional development workshops for computer and internet use, and creation of an IVC network and topic series. Grant monies supported the purchase and placement of videoconference units, installation of integrated services digital network (ISDN) communication.

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Address for reprint requests and other correspondence: G. B. McCombs, Center for Science Outreach, Vanderbilt Univ., 806 Light Hall, Nashville, TN 37232 (e-mail: glenn.mccombs@vanderbilt.edu).
The CSO maintains a small IVC studio at the Vanderbilt University Medical Center. The room is not altered for light or sound. A standard Polycom Viewstation 128 is connected to the university network. Presenters view the IVC through a Sony Trinitron 32-in. television monitor and face the primary camera and monitor while presenting. In addition, accessory presentation items include an internet-capable laptop computer, portable document camera (Elmo Visual presenter), video-capable microscope, and a second video camcorder. These devices provide other avenues of presentation and are directly connected to the Polycom unit. The inputs are changed via remote control to switch from one device to another. The audience typically views only one video device, including the primary camera, at any given time, although some units allow for a dual presenter-Powerpoint presentation mode. A standard table microphone provides audio input. A similar, more-portable unit is available for scientists who want to present from a remote location such as their laboratory.

As a stand-alone networked unit, the Polycom Viewstation is only capable of connecting two participants: the CSO (origin site) and one school classroom (remote site). To connect more than two sites, two options are available. First, the ISDN can be utilized to connect up to four total sites. Our unit is ISDN capable but can only connect to other units using the same ISDN telephone line-based connection. The second alternative incorporates a multipoint control unit (bridge). Vanderbilt Instructional Technology Services currently provides access to the bridge through a self-registration and monitoring software interface. The bridge capacity allows the inclusion of several site participants and can mix either ISDN or network internet protocol to connect. To maintain interactivity, most sessions are limited to the equivalent of three participating classrooms (~75 students).

Program announcements are made ~1 mo in advance to a list serve as well as more formally on the Center for Interactive Learning Collaboration (CILC) website (3). CILC serves as a national videoconference and distance learning resource for content providers and audiences and has increased the national visibility of this program. Potential participants are directed to the CSO videoconference website to self-register. It includes links to downloadable resources such as lesson plans, internet content, articles for review, discussion questions, etc. After the registration, an automatic e-mail confirmation is sent to participants with instructions regarding the connection protocol, videoconference conduct, and tips for preparing teachers and students before the session.

Research faculty members, clinicians, postdoctoral fellows, and graduate and medical students participate in this series and are defined as either scientists or scientists in training. Most volunteers are recruited through e-mails, posted fliers, CSO website requests, and university announcements. Although originally a volunteer-only series, the program has evolved to include a number of established transinstitutional partnerships (Table 1). At this time, over 100 scientists and scientists in training have participated.

Given the CSO medical school location and local expertise, ~75% of all presentations are biomedical in origin. Scientists and/or network internet protocol to connect. To maintain interactivity, most sessions are limited to the equivalent of three participating classrooms (~75 students).

Program Description

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Given the CSO medical school location and local expertise, ~75% of all presentations are biomedical in origin. Scientists

Table 1. University participants and IVC session topics

<table>
<thead>
<tr>
<th>Partner</th>
<th>Topic</th>
</tr>
</thead>
<tbody>
<tr>
<td>Department of Pediatrics</td>
<td>Ethics in genetic counseling; the human genome project; genetic screening</td>
</tr>
<tr>
<td>Ingram Cancer Center</td>
<td>Breast cancer awareness and prevention; health</td>
</tr>
<tr>
<td>Department of Electrical Engineering</td>
<td>Intelligent robotics</td>
</tr>
<tr>
<td>Department of Pathology</td>
<td>Normal and diseased organs; pathophysiology</td>
</tr>
<tr>
<td>Brain Institute</td>
<td>Stress; pain; brain function; senses</td>
</tr>
<tr>
<td>Dyer Observatory</td>
<td>Telescopes; galaxies; the birth of stars; the space shuttle</td>
</tr>
<tr>
<td>National Institute for Environmental Health Sciences</td>
<td>Mutations; poisons; medicine development; antibiotics</td>
</tr>
<tr>
<td>Second-Year Medical School Student Elective</td>
<td>Diet and exercise; recycling; media and self-image</td>
</tr>
</tbody>
</table>

IVC, interactive videoconference.

**Fig. 1.** Virtual Scientist program participant and session data (2003–2005).
and the CSO program coordinator develop a title and description and determine an appropriate target audience suitable for content, generally elementary (grades 3–5), middle (grades 5–8), and high school (grades 9–12). Presentations are typically 30–45 min in duration and emphasize interactions between scientist and students. Scientists are oriented to the equipment and presentation format prior to the scheduled event. CSO staff facilitate the presentation, including introductions, technical troubleshooting, school questions, clock management, and control of audio-visual devices, to enhance the flow of the presentation.

After the videoconference, e-mails are sent to schools and presenters to request teacher, student, and expert participation in an on-line evaluation survey. Surveys are anonymous, and questions are formatted as yes/no/not applicable questions or use a Likert scale. These data and overall participation totals have been maintained since 2003.

Program Evaluation

Figure 1 indicates the numbers of sessions delivered, individual schools, student participants, and numbers of states for the program. The program has expanded to serve a greater number of individual schools, states, and total students. Schools range from local Metropolitan Nashville Public Schools to districts in Washington and Florida.

An on-line survey assessed the impact of the Virtual Scientist program on students, teachers, and scientist presenters. Results from this survey are shown in Tables 2-4. Teachers and students who participated in our videoconferencing program overwhelmingly expressed their desire to participate in future conferences (97%; Table 2). Thirty-five percent of the teachers responded that a scientist had visited their classroom, and 88% of the teachers felt that this technology provided better scientist accessibility. Only 25% of the students responded that scientists had visited their classroom, and 69% of the students felt that this was an effective way to gain access to the scientists. Only 52% of the scientists had ever participated in a videoconference, yet 100% of the respondents indicated that they would participate again.

Tables 3 and 4 indicate responses by students, teachers, and scientists for technical issues and the overall program impact, respectively. This portion of the survey used a Likert scale (where 1 was strongly disagree, 2 was disagree, 3 was neutral, 4 was agree, and 5 was strongly agree). Data are indicated as the percent responses of combined Likert values 4 and 5 to acknowledge agreement with the statement.

Generally, participants found that IVC technical conditions were acceptable (Table 3).

Table 2. IVC survey for future participation and scientist accessibility

<table>
<thead>
<tr>
<th>Question</th>
<th>Students</th>
<th>Teachers</th>
<th>Scientists</th>
</tr>
</thead>
<tbody>
<tr>
<td>Do you desire to participate in future videoconferences?</td>
<td>97 (382)</td>
<td>97 (126)</td>
<td>100 (23)</td>
</tr>
<tr>
<td>Have you ever had a scientist visit your classroom?</td>
<td>25 (388)</td>
<td>35 (127)</td>
<td>N/A</td>
</tr>
<tr>
<td>Does this technology provide better scientist accessibility?</td>
<td>69 (335)</td>
<td>88 (111)</td>
<td>N/A</td>
</tr>
</tbody>
</table>

Data are percentages of total respondents, with the total numbers of respondents in parentheses. N/A, not applicable.

Table 3. Student, teacher, and expert responses regarding technical issues

<table>
<thead>
<tr>
<th>Question</th>
<th>Students</th>
<th>Teachers</th>
<th>Scientists</th>
</tr>
</thead>
<tbody>
<tr>
<td>I could see/hear the television well from where I was sitting.</td>
<td>63 (381)</td>
<td>85 (127)</td>
<td>N/A</td>
</tr>
<tr>
<td>I could see the individual slides well on the screen.</td>
<td>79 (378)</td>
<td>78 (116)</td>
<td>N/A</td>
</tr>
<tr>
<td>The time limit was adequate.</td>
<td>62 (381)</td>
<td>85 (127)</td>
<td>83 (26)</td>
</tr>
<tr>
<td>I could see the presenter well.</td>
<td>86 (381)</td>
<td>91 (126)</td>
<td>N/A</td>
</tr>
<tr>
<td>I was able to ask questions of the speaker.</td>
<td>74 (379)</td>
<td>85 (122)</td>
<td>N/A</td>
</tr>
<tr>
<td>I was able to interact with the speaker/students.</td>
<td>72 (379)</td>
<td>84 (124)</td>
<td>70 (26)</td>
</tr>
<tr>
<td>I felt the videoconference ran smoothly.</td>
<td>N/A</td>
<td>N/A</td>
<td>91 (26)</td>
</tr>
<tr>
<td>I felt that having a facilitator was needed.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Videoconferencing technology is an effective technique to visit a class.</td>
<td>N/A</td>
<td>N/A</td>
<td>83 (26)</td>
</tr>
</tbody>
</table>

Data are percent responses of combined Likert values 4 and 5, with numbers of respondents in parentheses. The Likert scale was as follows: 1, strongly disagree; 2, disagree; 3, neutral; 4, agree; and 5, strongly agree.

Overall, 70% of experts, 72% of students, and 84% of teachers found that the IVC interaction was technically effective, whereas 62% of students, 83% of experts, and 85% of teachers indicated an effective time limit. Students could see the presenter well (86%), could view presentation materials such as digital slides adequately (79%), and were able to ask questions of the speaker (74%). Teacher responses followed similarly positive trends. Students appeared to be more critical than teachers regarding adequate time limits (62% vs. 85%) and the ability to interact with the expert (72% vs. 84%). Experts aligned with students regarding interactions (70%) and with teachers pertaining to time (83%). Experts found that the session ran smoothly (91%) and IVC served as an effective classroom visitation technique (83%). In addition, the experts supported the presence of an on-site facilitator for sessions (91%).

IVC impact statements paralleled technical trends (Table 4). Both students and teachers felt that the scientist was effective

Table 4. Student, teacher, and expert responses regarding the impact of videoconferencing

<table>
<thead>
<tr>
<th>Question</th>
<th>Students</th>
<th>Teachers</th>
<th>Scientists</th>
</tr>
</thead>
<tbody>
<tr>
<td>The scientist was effective in delivering content.</td>
<td>76 (381)</td>
<td>89 (127)</td>
<td>N/A</td>
</tr>
<tr>
<td>I felt that the student/I was prepared for the topic being covered.</td>
<td>50 (381)</td>
<td>75 (127)</td>
<td>73 (22)</td>
</tr>
<tr>
<td>I felt that the students/I enjoyed learning science this way.</td>
<td>82 (382)</td>
<td>89 (126)</td>
<td>N/A</td>
</tr>
<tr>
<td>The presenter was effective in his/her presentation.</td>
<td>78 (381)</td>
<td>87 (127)</td>
<td>N/A</td>
</tr>
<tr>
<td>The topic was interesting.</td>
<td>68 (378)</td>
<td>92 (127)</td>
<td>N/A</td>
</tr>
<tr>
<td>An activity provided ahead of time would be helpful.</td>
<td>63 (369)</td>
<td>84 (126)</td>
<td>N/A</td>
</tr>
<tr>
<td>I felt that the class was interested in my topic.</td>
<td>N/A</td>
<td>N/A</td>
<td>77 (25)</td>
</tr>
<tr>
<td>Videoconferencing technology is effective for teaching.</td>
<td>N/A</td>
<td>N/A</td>
<td>87 (23)</td>
</tr>
</tbody>
</table>

Data are percent responses of combined Likert values 4 and 5, with numbers of respondents in parentheses. The Likert scale was as follows: 1, strongly disagree; 2, disagree; 3, neutral; 4, agree; and 5, strongly agree.
(76% and 89%, respectively) and enjoyed learning science in this manner (82% and 89%). While 73% of experts and 75% of teachers felt that the students were prepared for the conference, only 50% of students agreed. School participants felt that a pre-IVC activity provided ahead of time would have been helpful in preparing for the content (63% of students and 84% of teachers). Among scientists, 77% agreed that the class was interested, and none disagreed with this statement. Experts supported IVC as effective in teaching (87%).

DISCUSSION

The effectiveness of technology as a K–12 educational tool has been a point of contention since its initiation. Russell (10) reported that, for the most part, use of technology results in no significant difference with respect to learning outcomes. Why, then, does the use of videoconferencing continue to increase? Greenberg (5) contended that once educators accept that technology in and of itself will not significantly impact learning, then we can move ahead to use technology “to increase efficiencies, circumvent obstacles, bridge distances, and the like.”

Greenberg also reported that videoconferencing compares favorably with traditional instructional methods and expands the reach of education. Kriger (7) and Merrick (8) agreed that videoconferencing increases access to education. Cavanaugh (2) suggested that IVC can and should be used to “provide authentic connections to a learning environment beyond the school boundaries.”

In the present program, we focused on developing an IVC program that specifically links scientists to classrooms to enhance interactions between the expert and learner, eliminates geographical barriers, and expands the educational experience for students. Clearly, access to science experts is not a typical occurrence with a majority (65–75%) of students and teachers in this program. Here, most participants (69–88%) claimed that IVC was effective in promoting access to scientists.

A second outcome of the Virtual Scientist is reflected in the scientist response for IVC as an effective teaching tool (87%). Most agreed with the need for a provided facilitator (91%), which may contribute to their support of IVC. By creating a good working environment with adequate technical support, experts felt the videoconference ran smoothly (91%) and could concentrate on their presentation.

With 100% of presenters sharing a desire to participate in future conferences, it appears that they approve of the Virtual Scientist model. For faculty research scientists, the positive survey results may suggest that the pursuit of science outreach could increase within the context of an effective IVC program.

IVC serves as a convenient outreach tool particularly when one considers the demands of faculty teaching, research, and service responsibilities. For postdoctoral fellows and graduate students, IVC offers a unique teaching opportunity within a university that does not have teaching assistants.

For the students and teachers, how effective is this program for learning? The agreement to participate in future conferences (97%), in the effectiveness of the scientist content delivery (76% and 89%), and in the enjoyment in learning through IVC (82% and 89%) strongly suggest a positive learning experience. Further studies would be required to elucidate the specific impact of IVC on science aptitude. Given the enrichment quality of these interactions, and the plethora of variables that permeate an education, this would be difficult at best. Perhaps more realistically, and even importantly, increasing the interest in and pursuit of science and scientific careers may be more pertinent and plausible outcomes of this program.

Through this medium, the CSO also brings focus to the “how” behind science. The recently introduced “Virtual Lab Experience” showcases the scientist’s work in action on site through a portable IVC unit. Students and teachers can experience the cutting edge of Vanderbilt research and application by viewing images through a solar telescope at Dyer Observatory, activating heat shock proteins via lasers in Biomedical Engineering, and even challenging the abilities of ISAC, the robot located at the Center for Intelligent Systems.

In examining what makes videoconferencing successful, Amirian (1) supported the requirement for interactivity and urged educators to focus on enhancing interactions among presenters and learners. This interactivity supports more social learning, leading to the creation of a community of distance learners. Technical limitations may hinder this interactivity. A school may operate just one IVC unit located in their media center where a teacher pools three class sections to participate. This could add up to 60 or more students viewing a standard 32-in. monitor and exchanging dialogue through a single desktop microphone. Another difficulty is maintaining appropriate bandwidth dedication to the videoconference. Although all schools may have an internet connection, the “pipeline” is sometimes small and can restrict audio/video quality. The Virtual Scientist program attempts to alleviate some of these situations by setting limits on schools per session and working with school district technology staff to troubleshoot during test calls as well as structuring equitable question and answer segments within the session. Our “science hotline” e-mail address provides an avenue for those questions that could not be addressed or may arise once the content has been digested.

Our most successful conferences have been those where the teacher has prepared the class for the conference and students come with prepared questions. In addition, presenters who have now become “regulars” ask frequent questions to engage students in discussion to maximize participation. This is strikingly apparent in sessions led by genetics counselors, where questions are posed to students on topics such as ethical issues in genetic screening. Because no answer is incorrect, students feel the freedom to voice their opinion, oftentimes generating an informal debate between schools with the genetic counselor as a moderator. Even more rigorous, and the pinnacle of interactivity, are the use of Vanderbilt-constructed hands-on, inquiry-based science kits that have even been shipped to remote classrooms with experimental lessons led by graduate students from our campus. These examples support the suggestion that actively engaging students in the learning process should be a fundamental goal of content providers (11).

Most teachers agreed that a presession activity would prove helpful (84%). Yet 75% of the teachers agreed that the students were prepared, whereas only 50% of their students agreed with this statement. Who should be responsible for providing these activities and preparing students warrants further discussion. Given the primary responsibilities of university faculty members, physicians, career scientists, and their students, it is difficult to require the development of a detailed lesson plan. Although lessons were initially developed by CSO staff in
collaboration with experts, our approach has transitioned to
one of enrichment for the science teacher to increase educa-
tional impact by incorporating the expert content into their
standards-based curriculum. Ideally, as university–K–12 part-
tnerships proliferate, centers such as the CSO will facilitate
collaboration between the teacher and scientist. In turn, this
may aid in shifting science education toward a more research-
centered, scientific method approach.

Since its inception, several aspects of the Virtual Scientist
program have evolved. The CSO provides web-based self-
registration and postsession evaluation, oversees all manage-
ment and technical aspects of the sessions, and continues to
build formidable content partnerships with departments, cen-
ters, institutes, and student organizations across campus. For
example, medical school students are required to participate in
elective courses, many of which incorporate a community
service component. Students and their faculty advisors primar-
ily coordinate these courses. The Vanderbilt School of Medi-
cine “Innovate” course includes student training in community
health issues by Vanderbilt’s Dayani Center and implementa-
tion of a new medical campus recycling program. Our partner-
ship offers a unique conduit to educate the community with
these important messages. An added advantage to these part-
nerships is the ability to dedicate CSO staff efforts to other
forms of program advancement rather than volunteer recruit-
ment.

The Virtual Scientist program covers a broad spectrum of
disciplines, ranging from biomedical health sciences to nano-
technology and chemical engineering. Physiology serves as the
core of several regular sessions. “Freaky Friday” explores the
structure, function, and disease states of the human body
through partnership with the Department of Pathology and the
gracious loan of their organ specimens. “Spaced Out” exam-
ines the effects of microgravity on the neurovestibular, cardio-
vascular, and renal systems in conjunction with the Dyer
Observatory. This session includes a mini-experiment where
students compare heart rates in supine and standing positions to
understand the role of baroreceptors in blood pressure control.
In addition, the “Physiologist by Request” series connects
partner physiologists to high school teachers who can request
programmatic assistance.

The Virtual Scientist by 10.220.33.5 on June 16, 2017 http://advan.physiology.org/ Downloaded from

“real-world science.” The Vanderbilt CSO will continue to
provide opportunities for scientists to connect virtually to K–12
classrooms. As communication technology expands and be-
comes a stable and viable option for schools, the interactive
videoconference will serve as one tool to achieve this en-
deavor.

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REFERENCES

2. Cavanaugh CS. The effectiveness of interactive distance education tech-
nologies in K–12 learning: a meta-analysis. Int J Educ Technol 7:
3. Center for Interactive Learning and Collaboration. CLIC. Center for
   Interactive Learning and Collaboration (online). http://www.clic.org [6
   December 2006].
5. Greenberg A. Navigating the Sea of Research on Video Conferencing-
   Based Distance Education: a Platform for Understanding Research Into
   the Technology’s Effectiveness and Value (online). http://wainhouse.com/
   files/papers/wr-navseaslistedu.pdf [28 November 2005].
   Review. San Diego, CA: National Educational Computing Conference,
   2002.
   Education. A Report for the American Federation of Teachers. Wash-
   2005].
9. National Academy of Sciences. Rising Above the Gathering Storm:
   Energizing and Employing America for a Brighter Economic Future.
    Research Annotated Bibliography on Technology for Distance Education
11. Twigg CA. Innovations in Online Learning: Moving Beyond No Signifi-
    cant Difference (online). http://www.center.rpi.edu/PewSim/Mono4.pdf
    [27 January 2006].
12. Vanderbilt Center for Science Outreach. Vanderbilt Center for Science
    Outreach (online). http://www.vanderbilt.edu/cso [6 December 2006].