Engaging the Clutch of the Science Communication Continuum – Shifting Science Outreach into High Gear

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As technology races to realise the impossible, scientists might consider the potential problems inherent to a widening conceptual gap between us and those who fund our research and depend on us for their scientific literacy. In this opinion piece, I review the benefits of science outreach initiatives, focusing on short-term visits between school students and active researchers, and argue that there is sufficient evidence to support the adoption of a new primary medium for science communication that does not rely on the conventional media. By striving to place themselves within school classrooms, where face-to-face interaction can take place, scientists might be able to lend long-lasting benefits to society.

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Introduction

Public support of science research is entirely dependent on healthy science communication. Yet with the exponential growth of technology, the ability to communicate effectively with non-scientists is becoming increasingly challenging. To help avoid alienating the public, scientists might consider the benefits of interacting with young school students face-to-face. In this opinion piece, I review the potential for creating a more functional science communication framework through short-term science outreach programs.

In this issue of *Hypothesis*, the reader will find elegantly summarised, the general state of scientific writing and the common understanding that is prevalent in the majority of developed nations, as well as examples drawn from specific areas of scientific specialisation (1-7). The articles contain insightful experience-based recommendations on how to re-build the engine of what might become a crumbling science communication machine. I propose a complimentary solution, capitalizing on the proven benefits offered by science outreach programs.

Precedents

Favourable attitudes and early empowering experiences with science correlate positively with outcomes such as choice of

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high school science courses, college majors and careers (8). Benefits gained by students from even short-term science outreach programs, include an increased comprehension of science and a more positive impression of science research (9), conclusions confirmed by teacher assessments (10). Moreover, short-term visits of scientists to classrooms have proven to improve the overall academic performance of high-school students (11). Thus, science outreach can have positive effects on students' academic achievements and their view of scientific research.

In one study published in 2006 in *Science* (see ref. 12), youth science program volunteers and summer students completed a retrospective evaluation in which they ranked the value of specific skills acquired during participation in a short-term science program. Students indicated that they felt the program had improved not only their laboratory skills, but also their scientific thinking, general writing, presentation and communication skills. In turn, scientists who participated in the outreach activities felt the process of communicating science to students improved their own teaching, mentoring, organization and presentation abilities.

Clearly, both students and scientists stand to benefit from increasing the pervasiveness of science outreach programs. But there is also a wider, societal benefit, and it is this more general aim that is currently most in need of attention.

The Need to Shift Gears

I argue that any disconnect that may exist between scientists and the public has emerged due to a dependence on the conventional media for the disseminationand and explanation of important research findings. Universities and research institutions release headline statements for mass distribution to media streams, hoping one or more of these sources will deem the item newsworthy and initiate a report. While this does not constitute the entire science communication effort, it may be the most far-reaching and contains many inherent shortcomings (for a review, read ref. 2 (this issue of *Hypothesis*)) precluding it from ever becoming the ideal communication context.

One major problem with using the media as a vehicle for science communication is that journalists can only report on "sellable" stories, naturally favouring headline statements that generate the greatest interest and thus the greatest revenue. A substantial proportion of "unsellable" but nonetheless important research remains unknown to the public. A second major issue is that the media do not have the ability or resources to sufficiently judge the quality and credibility of data, thereby increasing the risk of widely distributing false conclusions. A third major problem is that interactions between the media and scientists can easily be subjected to governmental regulation. For example, Canada's current Prime Minister, Stephen Harper, recently instituted regulations that have resulted in Canadian climatologists feeling disconnected from the nation's media sources (13).

Further complicating the matter, scientific stories often contain an element of opinion for which multiple views are both accepted and desired. Yet when journalistic objectivity is applied to scientific topics, a fourth major, "balance" problem emerges: The sense of responsibility to balance a story may lead journalists to seek out an individual who will refute the original scientific claim, using either a different data set, or a different conclusion based on the same data set. The degree of specialisation of the information then requires that a third scientific expert judge the relative merits of these diverging opinions. To then truly present a balanced consideration of the topic, a fourth scientist

who disagrees with the third should be consulted; and a fifth scientist is next required to decipher whether the conclusions of scientist number three or four should constitute the "take-home" message. And so on. This absurd example demonstrates what, at least in theory, might be done in true objective journalism. In practice, at most only two scientists are consulted, and the information consumer is left to draw their own conclusions as to what the truth might be, perhaps not basing their decisions upon the data, but instead on the apparent character and appeal of the scientists interviewed, or on the recommendation of the news source.

creating a more functional science communication framework through short-term science outreach

Fortunately, this simplified description of scientific reporting is by no means ubiquitous, and many specialised publications and programs, such as *Scientific American*, *National Geographic*, or *Quirks & Quarks*, relate science ideas and discoveries to non-scientific audiences in a way rather deserving of congratulations. I do not attempt to convey that the media should not be used as a communication tool. Yet even with excellent journalism, one major limitation remains: The choice belongs to the information consumer as to whether or not they will take the time to flip through the glossy pages of a science magazine, or tune the dial to a scientific broadcast. Even if the media adhered strictly to an ideal method, however that may be defined, the public is not obliged to read, watch, or listen to the reports. This is why I argue, that the clutch of the science communication continuum must be engaged, and a shift to a new medium made. The conventional media, while a powerful tool to disseminate important information, probably should not be the main means of scientific communication. Instead, scientists need to do the communicating themselves, one-on-one with every member of the public – irrespective of the public's initial interest.

Shifting Science Outreach into High Gear

In my view, the primary aim for scientists wishing to close the communication gap between themselves and non-scientists, should be to bypass the media and take discovery directly to the public. While this could in theory be done through internet blogging or *wikipedia*, passive approaches such as these retain the limitation that the information consumers still control the terms of communication. It would be more ideal for scientists to target a captive audience that represents all sectors of society and includes, as nearly as possible, the entire population. I can think of just one venue that fits this description: the school classroom. In a classroom, students are mandated to be present, and more importantly, students are mandated to participate. They constitute an audience ensnared, expecting a lesson and ripe for a good time.

This is precisely the approach taken by the Canadian Space Agency in their on-going initiative to instil interest in the public for their publicly funded projects. The Agency holds an annual "Space Educators" conference at their headquarters with the exclusive aim of training teachers and other space enthusiasts (including myself) to visit classrooms and educate students about space and space exploration technology. Moreover, they demonstrate how to do this in a way that is fun, attractive and accessible. I attended the conference in 2009,

where I had the remarkable opportunity to speak live with astronauts Mike Fincke and Bob Thirsk as they floated by on the International Space Station, some 300 km overhead. It was an awe-inspiring moment that I never neglect to share with students when I visit their classrooms. The Canadian Space Agency incurs the expense associated with this initiative each year because they trust in the effectiveness of targeting children. The Agency knows that when it comes to helping a society understand the value and meaning of science, it is best to start with the young brain. They have also made the observation that the school system provides a convenient, ready-made conduit through which nearly the entire population can be reached immediately and cost-effectively.

The Numbers Needed to Get There

To achieve the type of fundamental paradigm shift that would arguably constitute the establishment of a new primary science communication medium, each classroom should receive the visit of one scientist at least once a year. Using Canada as an example and some rough estimating, I outline below the quantitative ramifications of this recommendation.

The total number of academic scientists in Canada is approximately 165,000 (14) and there are some 250,000 classrooms in the country (15). Therefore, to achieve the goal of one researcher per classroom, every academic scientist would need to visit about 1.5 classrooms per year. Since it is easy to visit 2 (or even 3 or 4) classrooms in a single day, a contribution of 8 work hours per year (including preparation, travel and execution time) from each scientist would suffice to surpass the goal of one scientist in every classroom. In my opinion, this is not too much to ask when considering the legacy of benefits to society and science that stand to ensue for years to come. From my own experience with science outreach programs, many scientists will choose to make multiple trips each year. Thus, with fewer than half of Canada's academic scientists participating, it is numerically possible to reach every single student, every single year.

When including the entire scientific and engineering workforce in Canada, the number of scientists more than quadruples (16). Therefore, if only 10-15% of Canadian scientists were to make an annual trip into a local classroom, a dozen scientists could reach each student by the time they finish high school. I argue it is time we make this happen.

Science Outreach Inititatives

The governments of many countries have established national science mentoring programs. *Questacon Science Squad*, a more than 30-year old Australian program, reaches over one million students each year (17). The Canadian Institute of Health Research also introduced a national mentorship campaign in 2007, called *Synapse*. In the three years since its inception, some 2000 scientists have joined *Synapse*; and between July 2008 and June 2009 alone, more than 100,000 students were reached, many via face-to-face interaction over the internet in remote regions of the country (18).

In 1991, Frazier & Hodgetts wrote of the American science communication problem (19), "[America] is already showing signs of losing its competitive edge in science and mathematics. Elementary, middle, and senior high school teachers cannot be expected to reverse this trend without help from every other sector of the educational enterprise. One relatively untapped resource that could be enlisted to combat this problem is the superb and highly qualified science/biology faculty of our colleges and universities."

Frazier and Hodgetts used this statement to support the establishment of the University of Kentucky Science Outreach Program. Currently there are calls to create a national US, or even global, science outreach engine (12, 20-22).

There also exist a number of growing non-governmental programs that connect scientists to students. The Let's Talk Science program, established in 1993, which is both privately and publicly funded, operates throughout Canada and draws over 1000 volunteers from all scientific fields. A large number of small, local programs have also emerged and often provide the best opportunities for researchers to to connect with local students.

It is numerically possible to reach every single student, every single year.

In Toronto, for example, the Mount Sinai Hospital Research Institute spearheads a program (*Scihigh*) that reaches over 5000 students each year through the effort of only about 50 active volunteers that make up but one tenth of the institute's trainee base. Programs like *Scihigh* render visiting a school classroom incredibly easy and effective. First-time participating scientists need prepare nothing at all. Easy to complete, fully prepared, hands-on experiments are provided, and the visit is lead by one or more researchers who are experienced volunteers. A major focus of *Scihigh* is to give scientists and students time to discuss research casually and on a personal level. In this way, scientists are able to speak to the central curiosities of individual students, and can highlight the significance of their personal research.

Thus, opportunities for scientists to enter the school classroom abound. The major barriers are no longer organisational. Instead, a perceived lack of time, insufficient availability of information facilitating participation and, sadly, a dearth of support from research supervisors are the primary deterrents for trainees considering engaging in science outreach programs (23). These challenges must immediately be addressed. As scientists, we need to remind ourselves of the greater context in which we perform our research and meet the challenge to provide every student with face-to-face interaction with a scientist, every year. It is our responsibility to understand, appreciate and cultivate the potential that awaits.

The Future

Science research is truly a global effort with researchers residing in one country often having trained in another. As such, it makes sense for knowledge translation science outreach projects to also cross political boundaries and distribute efforts around the world. This may be particularly effective in advancing scientific understanding in developing nations. If the recommendations made in this and similar articles (19, 24) are actively implemented, society as a whole stands to benefit. Even students who do not pursue a career in the sciences will, nevertheless, have a higher level of scientific literacy than would be possible if science communication efforts continue to centre on the conventional media stream. A more scientifically literate society, globally, will lead to more informed legislation and creative alternatives to complex problems. Science teaches critical thinking, after all.

Conclusions

An imperative component of a developed, civil society, is a public that at least partially understand the science of their own day. I argue that this is just as important as understanding one's history, culture or politi-

cal landscape. Scientists have for too long used the media as a primary medium for disseminating research findings to the public. A concerted effort should be made to put at least one scientist in each classroom once a year, something that can easily be done in scientifically developed areas, and using the internet, is feasible in remote regions as well. As put by Colwell and Kelly (24), "Excellence in education ultimately requires commitment from every part of the scientific community itself. We have to recognize that our educational roles are no less important than our other responsibilities as scientists and citizens. The world of future opportunities and economic leadership will depend on broadly educated people who can understand complex problems and learn new things. Scientists who contribute to education today have the power to open those doors for everyone." It is now up to us, the scientists, to recognise the benefits and take up the challenge. Engaging the clutch of the science communication continuum, and shifting our efforts into this new and more effective medium, stands to benefit us all. H

For more information on how you can participate in science outreach activities, visit:

Canada:
http://www.cihr-irsc.gc.ca/e/22973.html
http://www.letstalkscience.ca/en.html
http://www.scihigh.ca
USA:
http://www.nscdiscovery.org/
Australia:
http://www.questacon.edu.au
Europe:
http://www.juforum.de/
http://www.milset.org/en/milset.html
http://esdy.milset.org/
http://www.mintzukunftschaffen.de/

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15. Statistics Canada reports there are currently 5 million students enrolled in Canadian schools, who make up some 250,000 classrooms, each with 20 students. See: http://www.statcan.gc.ca/pub/81-582-x/2007001/4148950-eng.htm#3 [cited Sept 14th, 2010]

16. When including the entire scientific and engineering work force in Canada, the number more than twice doubles (source: Statistics Canada). See: http://www.statcan.gc.ca/daily-quotidien/060511/dq060511b-eng.htm [cited Sept 14th, 2010] and http://www41.statcan.gc.ca/2008/0193/ceb0193_000-eng.htm. [cited Sept 14th, 2010]

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