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Communicating science to college students and the general public

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Abstract

As teachers we try to find ways to effectively communicate with our students, in order to help them to learn. Education is a two-way process that consists of teaching and learning. Whether this package results in the desired effect (i.e., "education") depends on how well the subject matter is communicated. Obviously, effectiveness of communication depends upon transmission and reception, the ultimate goal being that the transmitted and received messages carry the same meaning for the teacher and student. In other words, we want the recipients of our communication to understand our words and phrases and concepts in the same way as we do. Whether or not we achieve this goal depends upon a variety of factors, including how instructors present their material, and how students learn. We also communicate science to the general public in different contexts.

One effective way to learn something is to teach it – something most of us have experienced. What better way for students to learn a concept or fact than to communicate it to the public? Here, I present our experiments at the University of Delhi in using this approach to convey the principles of evolutionary biology. Our annual celebrations of Evolution and Evolutionary Biology around "Darwin Day" (12th February, Charles Darwin's birthday) have turned out to be an excellent opportunity to illustrate this point. It is difficult to determine the results of these experiments, but anecdotally we can say that our efforts have been a great success in terms of garnering widespread interest and enthusiastic participation by students, faculty, staff and the general public.

Key words: Education, teaching, learning, effective communication

Learning via teaching and reaching the public

The basic principles of evolution that we seek to convey are about biological diversity, one, what is its history—who is related to whom? (best represented as a phylogenetic trees), and two, how does it arise? (by selection, both artificial and natural).

These concepts are presented in diverse ways – as interactive displays (with discussions around matter presented in calendars, picture books, and posters), games, a street play, and the more "conventional" mode of a film show followed by discussion.

Evolutionary history: The idea that evolutionary history is best represented as the "The Tree of Life" is introduced first, in a "***flip calendar***" that has a series of pictures of a large number of diverse creatures (including bacteria, mammals including humans, insects, fungi, plants, birds, etc.) that lead the viewer through the possible ways in which these taxa might be related one to the other. The presenter takes the viewer through these possibilities by asking a series of questions (Is the relationship ladder-like? Tree-like? If the former, and if we "descended" from bacteria, why do bacteria still exist?), leading to the idea that evolution is best represented as a tree.

Second, a ***poster on the evolution of humans*** shows the starting point as an unknown common ancestor that humans share with the chimpanzee, from where two branches arise, one leading to humans and one to chimpanzees. The human lineage is dotted with known direct fossil ancestors and side branches that lead to diverse humanoid fossils.

Third, this idea is reinforced in a ***board game ("Ancestry Mystery")*** that is played using discs that are in two different colours, say red and blue, with the darkest red depicting a human and the darkest blue depicting a chimpanzee. Disks of intermediate shades

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of both colours have to be arranged along a time-line to show the relationships between human and chimpanzee (as a forked arrangement of disks of increasing colour intensity with dark blue (chimpanzee) at the end of one fork and in dark red (human) at the end of the other, both placed in the present.

Natural and artificial selection

Fourth, using ***displays*** (posters and real vegetables) we ask the question, **"*Where did the cauliflower come from*?"** Using these exhibits, the types of changes thought to have occurred by the ***artificial selection*** of particular traits (juicy leaves, large buds, etc.) in the ancestral *Brassica oleracea*-like plant are explained by the presenters in interactive sessions.

Fifth, the idea of selection is reinforced by a ***predator-prey board game*** that allows the player (the "predator") to hunt for variably coloured "prey" items that are distributed in the board, whose colour matches that of one of the prey more than the other. At the start of the game there are equal numbers of both coloured prey, and the player can see, at the end of one round, that one of the colours "survives" better than the other. The presenter discusses differential survival and potential for greater reproduction of the prey that escapes, so that it can leave more of its kind.

Sixth and last, the ***street play*** in song and dance format as in the classic "nukkad natak," often considered to be the *pièce de résistance*, presents natural selection as a story involving themes such as dark- and light-coloured moths that are differentially captured in different backgrounds (dark or light) by bird predators, or the slowest-running hares in a variable population of hares in the jungle that carnivorous predators hungrily pounce on. This part of the event is relatively fluid because it is the most "presenter-centric" of the different items presented, and tends to vary with the composition of the students that participate. Each group of students removes, adds and modifies script and choreography in different ways.

The material—continuous creation and development

The basic material described was co-operatively prepared, starting in 2011, with post-graduate students (M.Sc., M.Phil. and Ph.D.) over several years using our understanding, imagination and material in the public domain; it continues to be modified. Every set of students comes with slightly different perspectives on presenting these concepts. As may be seen in the descriptions of these activities, the student presenter is crucial in executing the first five activities; therefore it is critically important that the material is discussed afresh with every new set of students as if it were fresh. The presenters have to "own" the ideas and material as if they created them—in a sense, they are creating the material with every iteration of each activity. This is what allows the student-presenters to fully understand the evolutionary biological principles that they are trying to convey.

What about the "public?" This is the most dynamic part of the entire exercise. Initially, we conducted the activities on or around Darwin Day in the Arts Faculty area at the University of Delhi. Here, the "public" was comprised mostly of university students from different disciplines, other academic and non-academic members of the university and a few passers-by. During those interactions we were sometimes drawn into philosophical and political issues related to the idea of evolution. In recent years, the activity has moved to the annual flower show, which draws a public of a much wider range of ages, backgrounds, and interests. It is a delight to see how student presenters handle, with great aplomb, the very diverse questions that they have to field in the latter venue (especially from school children). Perhaps because the philosopher tends not to attend the flower show, we tend to get into fewer "deep" discussions. The school children more than make up for this!

These activities are rewarding for all — the teacher that initiates it, the students that participate in developing and/or presenting the material, and the "public" in whatever manifestation. However, while we do not have an objective assessment of whether it promotes learning through teaching, many student-participants say that they have developed an abiding interest in evolutionary biology. This can only be considered as a positive pattern.

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