

Commonalities in Biology

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Abstract: Ernest L. Boyer has proposed the incorporation of what he calls the seven human commonalities into college courses. He believes that by doing so students will become less parochial and more global individuals. For the past two years, I have applied his commonalities approach to both a General Education course and an introductory course for biology majors. The commonalities have been presented in a student-oriented discussion format. Preliminary results based upon class participation, short essay exam questions, and the ability of the students to detect these commonalities in a wide range of organisms suggest that this format is a valuable teaching technique..

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Starting each semester with hope springing eternally in my breast and ending each semester with the discouraging realization that I have not reached many of the students and have failed to communicate to them the excitement and relevance of Life Sciences, I continue to invent or “borrow” new approaches to achieve the impossible task of turning every student into a biology major or at least into an individual with an increased appreciation for the value of biological knowledge. To this end, I attended seminars and workshops at our Center for Teaching and Learning; perused the Weekly Teaching Tips provided by the Center; attended a Sigma Xi presentation by Craig Nelson on the improvement of teaching; read a variety of publications, journals and books, on the subject; and talk with other faculty and students. In other words, I continue to try. Prior to the start of the 1997 Spring Semester, I came across a report by Ernest L. Boyer in *Rethinking the Curriculum* entitled “Making the Connections: The Search for Our Common Humanity”. He states:

“Today’s students live in a world that is economically, politically, and environmentally connected. Our shorelines are polluted, and the tropical rain forests are being destroyed at the rate of 100,000 square kilometers every year. I worry that education in this country is becoming increasingly parochial at the very moment that the human agenda is more global. Students are not becoming sufficiently well-educated about the world they will inherit.”

He states that an undergraduate curriculum should be based on what he calls the *human commonalities* — those universal human experiences that are found among all people and all cultures on the planet. He then proposes the question “What are these experiences that ‘non-uniform people’ have in common?” He lists seven commonalities.

Human Commonalities

1. We all experience life. All experience birth, growth, and death.
2. We all communicate with each other.
3. We all respond to the aesthetic.
4. There is an historic perspective; we all recall the past and anticipate the future.
5. We all organize ourselves into societies.
6. We all are embedded in Nature. We are interconnected.
7. We all seek to give meaning to our lives.

Starting in the spring semester, 1997 and continuing through the 1997-1998 academic year, I have attempted to apply these “commonalities” to the material covered in both an Introductory Biology course for majors and a Human Aspects of Biology course for general education students. I have presented these commonalities in the form of discussion questions along with other discussion questions contiguous with each topic covered.

Two days prior to each class period I provide the students with a relatively complete outline of the material to be covered and a set of discussion questions with commonality questions included. Normally we spend 25-35 minutes going over the material in the outline and then spend the rest of the 50 minute period discussing the questions. As anyone who teaches a General Education course or a freshman, Introductory Biology course for majors knows, the students don't enter the class eager to engage in discussions of a biological nature. Therefore, it usually takes about three weeks to encourage, trick, bribe, or threaten many of the students to play an active role in the class. In one particularly "difficult" General Education class in which the sound of participating voices wouldn't have muffled the sound of a pin dropping, I casually mentioned that a particular question would be included on the next test, and I felt confident that it was so easy we didn't need to discuss it. The metamorphose was rapid, amazing, and satisfying.

Hands were raised to object to my cavalier dismissal of the necessity to discuss the question and voices offered possible answers. During succeeding class periods, there was no shortage of student participation in considering the discussion questions. But regardless of the technique one employs to encourage participation, the objective is to help the students realize that their participation is encouraged to help them understand the material and perform better on the tests, not to provide another obstacle to their spending a nice, silent, comfortable 50 minutes in class.

Although it is somewhat more difficult to include the concept of Boyer's commonalities in a General Introductory Biology course than in a course stressing human aspects of biology, with the exception of numbers one and three it can be accomplished. Examples of the discussion questions utilized for certain topics in each course will provide an idea of the way this can be done.

HUMAN ASPECTS OF BIOLOGY—GENERAL EDUCATION COURSE

Topic	Questions
Introduction	<ul style="list-style-type: none"> • How does recycling of physical materials demonstrate that humans are embedded in nature, that all organisms are interconnected? • How does the concept of "Spaceship Earth" imply that all humans are interconnected and that we all communicate with each other?
The Cycling of Nutrients	<ul style="list-style-type: none"> • Relate the carbon dioxide levels in the atmosphere to the past and to the future. • How do the two types of biogeochemical cycles demonstrate the interconnected aspect of humans and the communication that occurs between them?
Human ecology	<ul style="list-style-type: none"> • Connected to the concept that we all seek to give meaning to our lives, what is one of the major ways that we measure the success of an individual in the United States? • Compare this with the way we measure success of an individual plant or animal in a natural ecosystem. • All organisms experience birth, growth and death. Relate the factor of pollution to these stages of life.
Population	<ul style="list-style-type: none"> • We all experience life and we all have a historic perspective. Relate these to the significant differences in the average life expectancies in various regions of the world.
Fertilization & Development	<ul style="list-style-type: none"> • Is there any communication between the early embryo and the mother? • How does one person giving birth to a child impact society in general? • Is there any evidence that the developing embryo organizes itself into societies? Explain.
Aging	<ul style="list-style-type: none"> • We all experience life, but has technology encouraged us to think differently (non-traditionally) about both life and death? • What social and economic changes will be required as the number of individuals over 65 increases? • We all seek to give meaning to our lives. Are the quality and quantity of life important aspects of this meaning?
Cancer	<ul style="list-style-type: none"> • Does cancer violate the concept that we all experience birth, growth, and death? Explain.
STDs	<ul style="list-style-type: none"> • What evidence do we have that HIV communicates with cells in the human body? Is there any evidence of an historical perspective in this relationship? Explain.

**LIFE SCIENCES 101 -- INTRODUCTORY COURSE FOR
LIFE SCIENCE MAJOR AND MINORS**

Topic	Questions
Bacteria	<ul style="list-style-type: none"> • Discuss the history of the use of bacteria to process certain types of food. • How is <u>E. coli</u> interconnected to human beings?
Protista	<ul style="list-style-type: none"> • How does the relationship between a parasite and its host indicate a historical perspective and a type of communication?
Fungi	<ul style="list-style-type: none"> • How are fungi interconnected with humans? • It is said that humans organize themselves into societies. Is there any evidence that fungi do the same? Explain. • Is there any historic perspective in the relationship of fungi and humans?
Mosses and Ferns	<ul style="list-style-type: none"> • Is there any evidence of communication between moss plants? Explain. • Is there evidence of a historical perspective to ferns? Explain
Angiosperms	<ul style="list-style-type: none"> • Give examples of how flowering plants are embedded in nature. • How does our use of flowering plants give evidence that we respond to the aesthetic?
Plant Growth & Development	<ul style="list-style-type: none"> • What is the communicating messenger in the case of seed germination? • What is the reason(s) that all cells don't receive or respond to the same messenger in the case of plant hormones?
Plant Structure	<ul style="list-style-type: none"> • Relate birth, growth and death to a xylem vessel.
Tour of the Cell	<ul style="list-style-type: none"> • Give evidence that organelles within the cell are interconnected. • Trace the birth of a protein; include involved structures

**LIFE SCIENCES 102 -- INTRODUCTORY COURSE FOR
LIFE SCIENCE MAJORS AND MINORS**

Topic	Questions
Evolution of Animal Body Plan	<ul style="list-style-type: none"> • Are cells able to communicate with each other? Give evidence of this from the material covered today. • Is there any evidence of history in this material? Give examples. Suggest where this history is written. • When a cell becomes a tissue, what changes occur in its functions? • Compare this to a human being becoming a member of society.
Classification of Animals	<ul style="list-style-type: none"> • Is there a historical perspective to the different phyla of animals? Explain. • In order to add a little aesthetic value to your study of the phylogenetic tree, make a sketch of the tree with each phylum represented by an ornament which depicts the structure, shape, and gross anatomy of an organism representing each phylum.
Platyhelminthes	<ul style="list-style-type: none"> • What evidence is there that parasitic flatworms communicate with their host and have an historical relationship with the host?
Annelida	<ul style="list-style-type: none"> • In what ways are earthworms interconnected to humans?
Insecta	<ul style="list-style-type: none"> • Do insects belong to societies? Explain.
Mammalia	<ul style="list-style-type: none"> • How does the placenta suggest cooperation between humans? • How do parents communicate with offspring prior to and after birth?
Genetic Material	<ul style="list-style-type: none"> • What are some of the ways that a parent communicates with its offspring?
Vertebrate Development	<ul style="list-style-type: none"> • The development of the amphioxus embryo and the frog embryo appears to be very different. What evidence is there of historical connection? • Do cells of a developing embryo arrange themselves in societies?

EVALUATION

A faculty member at Indiana State University provided an interesting insight into evaluating a new program or method. She said that in China, teachers conduct an educational experiment for a minimum of three years before they attempt to evaluate it. She further stated that after one semester or one year, an evaluation merely examines an adjustment period. I hope the major benefit of this experiment will become apparent during the students' upper division biology courses that occur largely in the junior and senior years. However, being an impatient faculty member not in China, I have attempted at the end of each semester to evaluate the affect of the commonalities approach with its increase in class discussion.

One affect is the performance of the students on short, discussion questions on the exams. Prior to changing the class format, students did poorly on discussion questions. In fact, a significant percentage would answer the objective questions and omit many of the discussion questions. Now by the second or third exam, the average grade for the discussion questions is better than for the objective questions.

Another affect is that students play a much more active role in the learning process. Answers to discussion questions are often handled by a row of students. This not only takes the onus off an individual student but also allows the students to test their answers in a small group before presenting them to the whole class. After three semesters of utilizing the discussion approach, the students now enter class knowing that they are expected to help educate each other. This involvement has continued into succeeding courses. Students who completed L. Sci. 102 in the spring of 1997 have now completed two other biology courses. Faculty in these courses have informed me that the students have continued to participate in class much more than students in the past.

An evaluation of the commonalities approach suggests several additional outcomes. The students become aware that all organisms communicate within the individual organism and between organisms. They realize that most communications are done by chemical molecules. As the semester progresses, they realize that whenever organisms interact or there is an action within an organism there must be communication signals. The ideas that all organisms are interconnected, that we as humans are directly or indirectly affected by most other organisms, that we in turn have an effect on most other organisms surface relatively early in the semester. Students also learn that only humans keep written history records, but all organisms, including humans, keep their history in their genetic material; and that a systematic development of an organism requires a precise set of records or evolutionary history.

Using the commonality "All experience birth, growth, and death", which can be demonstrated in a wide range of structures from molecules through cells to whole organisms, I find it interesting to observe the students determining when and where molecules are "born, live, and die." The students have an interesting time learning that an enzyme molecule is "born" at the ribosome, modified in the Golgi complex, lives for a relatively short period of time during which it catalyzes a specific reaction, and then at some point, difficult to determine, is degraded, "dies." There is little unanimity when the students consider when an amoebae is born; some suggest this occurs just after its predecessor underwent fission, but others argue that its birth goes way back. Determination of its time of death is not easy for the students to agree upon. Did it die when it underwent fission or does it continue to live because a part of it makes up each of the two resulting amoebae? Does it continue to live in each succeeding generation? Does it live forever or is there a point at which none of the original organism exists? Some of the students argue that multicellular organisms, that give rise to offspring, do not die as part of them continues to live on.



The importance of these discussions lies not in arriving at a "correct" answer but in the thinking required to consider the question. Based upon the definition of a tissue as a group of like cells performing a specific function, the students recognize that a grouping of individual cells or organisms forms a type of society; and the different types of cells and tissues constituting an organism function as a complex society. Using the term "society" "in a broad sense, all multicellular organisms encompass many different societies. Organisms in turn are organized within certain social groups, i.e. Hymenoptera demonstrate a high level of social organization.



By seeking the commonalities in each group of organisms, the student can see threads that are woven through all living organisms. It is easier for them to learn general concepts that organisms have in common rather than a great number of specific details indicating differences between organisms. It is hoped that they will retain general concepts for a longer period than they do specific details; studies have shown that major percentage of specific details are lost in less than a year.

The commonalities and increased class discussion approach impacts teaching as well. I enjoy

the class a lot more. The students often contribute suggestions and ideas about the material that are humorous yet original and thoughtful. I teach two sections of the same course during the fall semester. Whereas in the past the second section was repetitive and somewhat boring for me, now each section is a unique experience because the students and their ideas are unique. Student involvement is something most teachers desire, and this approach certainly achieves

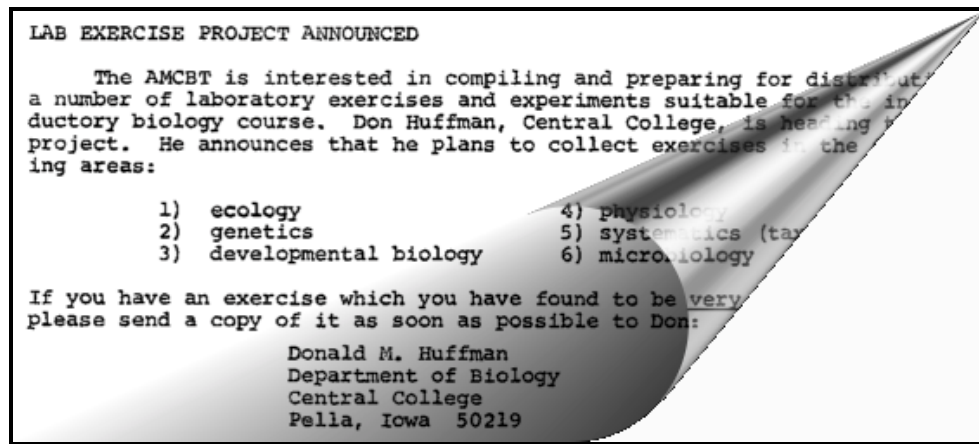
this. Dealing with the concept of commonalities has required me to view things differently and I have learned as much or more than the students. In a television advertisement for a food product two children were undecided whether or not to eat it; they gave it to a younger child. As the child ate the food, the look on his face indicated it was good, and the other two children remarked "Mikey likes it." In regards to the commonalities approach "Bill likes it."

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