Appendix A

# GENERAL EDUCATION AT THE UNIVERSITY OF MASSACHUSETTS-BOSTON

Besides providing training to pursue a satisfying career, the undergraduate curriculum at UMASS/Boston seeks to develop the ability of students to undertake a life-time of intellectual inquiry and continued learning. To this end, the curriculum emphasizes both depth and breadth of learning. Depth is achieved by completing a major in a particular discipline. Breadth of learning is the aim of General Education requirements. To meet - and relish -- the challenges of a complex and changing world, students must develop habits of **critical analysis and logical thought, master verbal and quantitative reasoning,** understand **human diversity,** and learn about the **principal approaches to knowledge.**

## Critical Analysis and Logical Thought

The habits of critical analysis and logical thought that are important to all forms of intellectual activity come from frequent consideration of complex problems. These habits can be learned in a wide variety of contexts, ranging from analysis of history to computer programming. Analytical thinking begins with raising and clearly defining issues so as to form answerable questions or testable hypotheses, proceeds through the gathering and evaluation of appropriate evidence, and culminates in the formation of some reasoned conclusion or judgement. Critical analysis must include consideration of alternative or opposing viewpoints. In addition, critical evaluation requires an awareness of the problems of the reliability and relevance of information, and the possible biases of researchers and their sources. An analytical intelligence is also self-critical -- always ready to reconsider a hypothesis or revise a conclusion on the basis of new evidence.

## Verbal and Quantitative Reasoning

Verbal and quantitative reasoning, at the collegiate level, provides the foundation for intellectual inquiry. Symbols (words, phrases, numbers, graphs) are the vehicles of thought -- they enable us to communicate our thoughts, and they also give us the ability to abstract and manipulate simple ideas to form the complex associations and logical sequences that are crucial to analytical thinking. This is why the powers of critical analysis and logical thinking are so closely related to the powers of expression. Many complex ideas cannot be fully formed, tested, or appreciated until they have been given symbolic expression in speech or writing. Reading and listening skills are required to assimilate the many concepts given formal expression in intellectual discourse. The structural principles and procedural rules for symbolic argument, as used in verbal and quantitative reasoning, must be mastered by the educated person.

## Human Diversity

Patterns of thought and behavior are derived from human interaction with the natural environment, exchanges among cultures, interaction between social groups and the legacies of social history. In a world growing smaller because of rapid advances in communications, increases in mobility, and changes in life styles and work environments, contact between people of different backgrounds becomes more frequent. The perspective gained from studying human diversity helps us to value the variety of individual and cultural traits we encounter. Learning how different patterns of thought and behavior develop helps us understand the richness and complexity of diversity in our society.

## Principal Approaches tc Knowledge

Exposure to the principal different pathways to knowledge gives a broad appreciation for the unique perspectives offered by each, and for the relationships between them. Groups of disciplines (for example, the Natural Sciences) share common approaches to knowledge, with similar intellectual perspectives and similar methods. Intellectual consideration of a particular issue will often require the perspective and methods of a particular pathway to knowledge, as well as critical thinking and the

application of verbal or quantitative reasoning. Understanding the different methodological approaches used in each area opens up a wide array of issues for intellectual analysis and discourse.

OBJECTIVES

These four major goals of General Eduction gives rise to a set of eight objectives, encompassing critical analysis and logical thought, verbal and quantitative reasoning, human diversity, and four principal approaches to knowledge -- Natural Sciences, Social and Behavioral Sciences, Arts and Humanities, and World Languages and Cultures:

Objective 1: Students will learn about the procedures of critical analysis and logical thought, with emphasis on disciplined inquiry, including the development of appropriate questions, the evaluation of evidence, and the formation of a reasoned conclusion or judgement.

Objective 2: Students will demonstrate the ability to read and listen critically, and to speak and write effectively.

Objective 3: Students will demonstrate the ability to reason quantitatively and use formal systems to solve problems of quantitative relationships involving numbers, formal symbols, patterns, data, and graphs.

Objective 4: Students will learn about human diversity, including how different patterns of behavior and thought evolve and how development of cultures is influenced by interactions among different social groups.

Objective 5: (Natural Sciences) Students will learn how the laws of the physical and biological world are derived through observation, theory, and experiment. In this age of expanding scientific knowledge and powerful technologies, an educated person should understand the importance of falsifiable hypotheses, the nature of scientific "truth," and the impact of science on society.

Objective 6: (Social and Behavioral Sciences) Students will learn about the nature and development of human behavior and institutions in modern societies, so as to become aware of the complex and ambiguous nature of human experience.

Objective 7: (Arts and Humanities) Students will develop an informed appreciation of the arts and humanities, which encompass history, philosophy, literature, the fine arts and the performing arts. Students will learn how people have come to understand and express artistic, aesthetic, moral, spiritual, and philosophical dimensions of the human condition.

Objective 8: (World Languages and Cultures) Students will learn how language and culture impose their own structurings of knowledge. This may be achieved through intensive study of unfamiliar cultures, or by the study of a foreign language or foreign literature in translation.

Each college will implement a General Education program that meets all eight objectives for all students and also comprises at least one third of the total curriculum.

## II. THE AIMS OF A GENERAL EDUCATION PROGRAM

The GESC has adopted the Faculty Council Principles and Objectives for General Education of 1994 as a context and a persistent point of reference for our deliberations. Although we have not hesitated to take those principles to a further level of specificity, it is our belief that nothing we recommend subverts or negates the work that has already been done and approved. We value the work of our colleagues on previous general education task forces and those who have been active in earlier and ongoing collegiate efforts at curricular innovation.

The GESC has attempted to recast the list of principles and objectives into a narrative that explains the aims that underlie these principles and how they constitute the common ground on which general education curricula in the colleges should be built. A concise narrative account of the aims and means of general education is, we believe, necessary to create a fresh understanding of the value and desirability of a generally educated person and to counter the habits of thought that conceive of "general education" as a set of hurdles to be negotiated, or as a checklist of impediments to the degree to be "gotten out of the way" as rapidly and painlessly as possible. The following narrative, we believe, reflects a clear set of academic and cultural values; it also provides students with a rationale that articulates the logic and integrity of general education requirements for the baccalaureate degree.

> *The aim of undergraduate education is to prepare students to develop a rational, affective, imaginative, and self-conscious capacity for learning. To do so, they must be able to engage in critical analysis using various communicative skills, which may be written, oral, numerical, or graphical, applied to varied objects of analysis. They should also be acquainted with the disciplinary frameworks which have historically structured such intellectual inquiry. Their sophistication should be cultural as well as intellectual, recognizing diversity of viewpoints, diversity of experiences, and diversity of values. Finally, knowing should be connected to doing. Because the generally educated person is also a citizen, students should be able to apply these tools of critical analysis, communication skills, disciplinary and interdisciplinary approaches toward investigating, valuing, and acting on behalf of the self, others, and the communities to which they belong.*
>
> *The desired product of general education is a person with the tools and habits of mind needed for ongoing learning, responsible participation in intellectual and civic life, and the capacity for continuing adaptation and growth. The specialized knowledge a graduate possesses is the province of the major field or professional training; general education, while also concerned with what an educated person knows, has a special interest in the kinds of things an educated person knows how to do.*

*If the fundamental aim of a general education is to outfit students for the lifelong pleasures and responsibilities of continuous learning, critical awareness, problem-solving, and civic participation, the following means must be included in the general education program for all students:*

*Students must be able to engage in critical analysis and purposeful synthesis, making effective use of organized observation, skillful evaluation of sources of information, reliable generalization from data, and rational argument.*

*Students must acquire the skills of communication and expression, including the capacities for self-expression and the articulation of ideas, the capacities for listening to the expressed ideas of others with sympathetic attention and critical detachment, and the capacities to critique and revise one's own expressed positions. The modes of expression in which students should develop some familiarity and facility include the verbal (both written and oral), the visual and graphical, the numerical or quantitative. In a diverse global community and a technologically sophisticated society, students should also be able to communicate in more than one language and should know how to use new technologies of information and communication.*

*Students should be able to apply their training in critical analysis and communication to various objects of study, sources of information, and forms of expression, which may include texts (written, visual, or auditory); material culture; empirical data and fieldwork observation; performance; concepts and abstractions; theories and ideologies. Such study depends on understanding of and practice in the modes of scientific investigation, moral and ethical reasoning, historical, cultural, and multicultural research, creative expression, aesthetic judgment, and quantitative analysis.*

*Students should have an appreciation for the great variety of perspectives on reality and be introduced to the disciplinary frameworks which have emerged historically as the means to organize intellectual and professional inquiry. While students will achieve expertise in some area of specialization in their undergraduate studies, they should also become familiar with the assumptions and methods of other disciplines and other approaches to reality. Understanding that there are diverse ways of knowing, each with its characteristic assumptions, questions, methods, and structures, students may perceive the advantages of multidisciplinary approaches and the limitations of disciplinary boundaries.*

*Students should demonstrate the ability to extend their learning beyond the classroom, applying and integrating the knowledge, modes of thought, research methods, and expressive skills learned throughout the curriculum.*

*Students should be educated for the future, with enlarging awareness of the necessary, the possible, and the desirable. At the completion of their degree students should be in possession of their own intellectual frameworks and imaginative capacities for understanding themselves, for recognizing and appreciating the cultures and views of others both like and unlike themselves, for generating ideas and making meaning, and for engaging in thoughtful discourse about and responsible action within the worlds around them, from the local community to the international sphere.*

## Executive Summary

Literacy in science has been defined as "the capacity to understand, at least at an elementary and inquisitive level, the phenomena of nature and the products of human technological endeavor" (National Research Council, *From Analysis to Action*, 1996, p. 3). This capacity includes a working knowledge of the basic methods of science and its major explanatory principles, allowing a scientifically literate person to use the tools of science in various contexts and to participate in policy debates regarding science from an informed vantage point.

A strong rationale for including science education as an integral part of general education can be drawn from the following observations: scientific literacy is a part of modern cultural literacy to which all students are entitled; a basic knowledge of scientific process provides a powerful and generally useful way to learn about the world and to evaluate information encountered as part of daily life; a basic understanding of scientific principles and processes is critical to informed and responsible decision making in the public arena. We have a responsibility to make science understandable to all students, not just to science majors. We have a special obligation to teach those who will become K-12 science teachers. Scientific literacy is at a dangerously low level in our country, with an entire generation receiving inadequate education in science from kindergarten through college. The current reform of general education at UMass Boston provides an excellent opportunity for instituting changes that will provide access to science for all our students, restructure the teaching of introductory science to meet the goals of general education, and provide a university wide curricular structure that will ensure experience with science as part of every undergraduate's program of study. (see Section A of the report)

In response to the Charge for the Working Group (see italics below) we have reached the following conclusions and recommendations:

1. ***What should be the goals of the science component of general education? What should students know about science? What should they be able to do scientifically?***

   Specific aims for students outcomes are that all students should
   - gain a basic understanding of the natural world as a reality governed by universal laws and principles
   - learn that science is a major human invention, a way of knowing that has its own characteristic processes, strengths, and limits
   - become able to see science as a systematic endeavor, rather than as a collection of isolated facts, and to place scientific knowledge in a broader context that includes human values as well as other forms of knowledge
   - understand the limits of science as a way of knowing and be able to distinguish between those questions for which the scientific method is appropriate from those in which it is not
   - gain some experience with different scientific disciplines and principles
   - learn the basic relationships between scientific process and scientific understanding
   - acquire the ability to distinguish scientific from pseudoscientific reasoning
   - become able to make appropriate use of basic scientific methods to evaluate evidence in the course of making decisions on personal and sociopolitical issues
   - develop confidence in their ability to acquire new scientific information as needed throughout life and to understand new scientific discoveries and technological innovations

2. ***How should the science component be taught? What sort of learning environment would be best suited to accomplish the goals.***

   We recommend that

   - the student outcomes be achieved by completing three approved general education science courses or the equivalent of nine credit hours in alternate structures such as shorter course modules, semester long courses worth more or fewer credit hours, competency-based educational experiences as defined in CPCS (see Section F1). One of the three courses may be in

mathematics. Science and nursing majors achieve the same objectives through extensive exposure to and participation in science through their major program (see Section F3)

- general education science courses be evaluated by a general education science committee and must meet the following criteria:
  - each course must have science content as a central focus. The National Science Education Standards should serve as a guide for appropriate science content (see Section D)
  - the course should speak to the relevance and value of science to society and/or culture, as well as to the uses and abuses of scientific understanding and investigation (see Section D2 and G6)
  - each course must have a hands-on, inquiry-based component, so that students actually engage in the process of investigation. This component would not necessarily take the form of a traditional, weekly three-hour laboratory (see Section G3)
- the desired student outcomes be achieved in a learning environment in which the student plays an active role, is part of a community of learners and which recognizes that the learning experience is personal (Section G )

3. ***How do other institutions provide science offerings in general education, and what pedagogical strategies do they use?***

Review of general education in 31 other universities reveal that, in all cases, the science requirement is either two or three courses. In most of these universities there is also a mathematics requirement (see Table in Section E). Descriptive summaries are available as a supplement.

4. ***When, over the range of baccalaureate studies, would be the best time for the science component? How might the rest of the curriculum support or complement a science component in general education?***

We believe it important that students be exposed to science concepts, processes, and applications throughout their undergraduate years. To this end we recommend that

- the general education science courses as described above be taken anytime after the second semester and when the students have achieved a desired level of competency in writing and in mathematics, quantitative reasoning and computer skills (Section F4)
- mathematical, quantitative reasoning and computer skills be assessed and addressed during the first year along with writing (Section F4)
- science be infused into the first-year and capstone experiences, as well as, where possible, into courses in non-science departments (see Section F5 and H)
- we explore additional ways of enriching the science experience of both science majors and non-majors on the campus, perhaps through formal interactions between two groups of students, development of science learning centers, and innovative technologies.

5. ***What staffing and resource needs are needed to provide "science for all students" who are baccalaureate candidates in the four-year undergraduate colleges?***

Resources will be needed

- to teach approximately 1450 additional enrollments (Section G2)
- to staff equip open-laboratory facilities to allow students and faculty flexibility in scheduling hands-on laboratory exercise (Section G2)
- to support faculty in development of new courses and mastering new pedagogies, possibly through a new Center for Science Education (Section H,G3)

APPENDIX D

Mathematics/Quantitative Reasoning Subcommittee

Patricia Davidson, Linda Kime, Paul Klein, Jack Lutts, Mark Pawlak, Mark Schlesinger, Steve Schwartz, Richard Truesdell, Jenny Wagner, Peter Westort

Writing/Composition Subcommittee

Bob Bertone, Judith Goleman, Donna Kaye, Tom O'Grady, Barry Phillips, Vivian Zamel

World Languages and Cultures Subcommittee

Efrain Barradas, Fiora Bassanese, Paul Bookbinder, Reyes Coll, Marie Kennedy, Brian Thompson

Science Education Subcommittee

Christine Armett-Kibel, Ron Etter, Terry McLarney, Celia Moore, Mary O'Brien, Nareschchandra Shah, Rachel Skvirsky, Millicent Riggins

First Year Experience Subcommittee

Sarah Bartlett, Kelly Clark, Joan Garity, Hannah Gilman, Alan Harwood, Jean Humez, Susan Irvings, Ann Jenkins, Daniel Ortiz, Emilie Steele

Other subcommittees will be organized or reconvened.