Practitioner's Portfolio

Peter J. Taylor
Program in Critical & Creative Thinking
Graduate College of Education
University of Massachusetts, Boston

Under development, 29 September 2001. Please excuse not-yet-implemented links and / or notify me.
All students whose work is included here have given permission.

This Practitioner's Portfolio consists of seven binders.

1. A personal statement, Curriculum Vitae, Annual Faculty Reviews, and 4th year reviews
2. Publications
3. Book Manuscript
4. Review of courses
5. A set of exhibits from Teaching and Advising
6. Fourth Year Review Practitioner's Portfolio
7. Exhibits related to Service and Institutional Development

I welcome dialogue around the different components of the Portfolio to help readers appreciate work in areas or directions unfamilar to them. Preparing a Portfolio also corresponds to my view that formal reviews should attend to process as well as product. That is, for reviewers to be confident in continued effectiveness of a colleague, they should have evidence of the faculty member's on-going process of assessment and development of research, teaching, and responding to institutional challenges, and of cross-fertilization between those three aspects of a scholar's work.

Detailed Table of Contents

Binder 1. PERSONAL STATEMENT with C.V., Annual Reviews, and 4th year reviews attached

From Critical Thinking to Reflective Practice, Especially about Environment, Science, and Society

This statement can stand alone as a summary of my recent work and future plans, but is better read with reference to the full Practitioner's Portfolio. Notes in the statement refer readers to relevant sections in the Portfolio and associated websites. Footnotes in the version here refer to abbreviations of publications and presentations, given in full in my curriculum vitae.

- **Curriculum Vitae**, with links to abstracts of many publications,
- **Annual Faculty Reviews**, 1998-99, 1999-2000, 2000-01
- , Reviews [not yet included], and Responses [not yet included]

Binder 2. PUBLICATIONS

- P / reprints of articles prepared or published since 1998, plus a selection of previous publications submitted to outside reviewers [List only included in web version]
- Works in progress [see c.v.]
- Earlier publications [see c.v.]

Binder 3. BOOK MANUSCRIPT

Manuscript of The Limits of Ecology [excerpt from the INTRODUCTION only included in web version]

Binder 4. COURSES

Preceding the material on the courses:

- section II of my personal statement;
- a summary my advising and independent studies;
- background on some anomalies in my record; and
- some unsolicited appreciations [not included in web version].

For each course taught in 1998-01 I include a review of:

- the original objectives for the course (which should be read together with the description and goals stated in the syllabi);
- challenges encountered and my responses; and
- future plans.

Each review is followed by:

- the syllabi;
- summaries of the GCOE evaluations;
- summaries from the written course evaluations I designed; and / or
- the originals of those evaluations.

Additional material related to teaching and advising is contained in the exhibits in Binders 5 and 6.

Courses

1. CCT670 Thinking, Learning and Computers
2. CCT698 Practicum: Processes of Research and Engagement
3. CCT601 Critical Thinking (with A. Millman)
4. CCT611 Science in Society [Seminar in Critical Thinking]
5. CCT693 Seminar in Evaluation of Educational Change
6. CCT694 Synthesis Seminar
7. CCT640 Environment, Science &Society [C&CT in Sci. &Tech.]

8. Ed 610 Computers, Technology, and Education

Additional special topics courses I organized:

9. CCT697 New Directions in Science Education
10. CCT697 Critical and Creative Thinking in Practice
11. CCT697 Critical and Creative Thinking in the Workplace

New courses, Fall 2001:

12. CCT611 Making Sense of Numbers [Seminar in Critical Thinking]
See also new syllabi for CCT698 and Ed 610 in sections above

Binder 5. EXHIBITS from Teaching and Advising

The exhibits have been selected to illustrate the sections discussed in Section III of my personal statement.
See Table of Contents

Binder 6. FOURTH YEAR REVIEW Practitioner's Portfolio and attachments

- Statement, Portfolio
- Earlier review of Courses, superceded by Binder 4
- Exhibits
  These were organized around the four pedagogical goals introduced in the personal statement: Reciprocal animation, Critical thinking, Ongoing Development of Pedagogy, and Heterogeneous construction. Given that research and writing were conveyed in my publications, the exhibits were drawn more from my work teaching and advising, and my contributions in service and institutional development. Each set of exhibits was introduced in a cover page.

- RECIPROCAL ANIMATION -- two-way interaction between the sciences and interpretations from STS disciplines
  - A.Courses modeling Reciprocal animation
  - B. Publications resulting from linking my scholarship and teaching
  - C. Conceptual exploration and theoretical innovation
  - D. Case studies
  - E. Institutional initiatives
- CRITICAL THINKING -- contrasting the paths taken by science, society, learning, and people's lives with other paths that might be taken, and basing actions upon the insights gained

F. Writing for learning and reflection
G. Making comments to stimulate rethinking and revision
H. Exposing the constructedness of teaching and learning
I. Teaching / learning as a joint dynamic
J. Empowerment to act upon critical thinking
K. Advising towards lifelong learning
L. Facilitating trans-disciplinary exploration

- ONGOING DEVELOPMENT OF PEDAGOGY -- experimenting, innovating and developing better ways to learn from teaching about teaching and learning
  M. Developing a large range of CCT courses
  N. Experimenting to develop STS and CCT pedagogy
  O. On-going development of courses
  P. Varieties of course evaluation
  Q. Promotion of teacher-teacher interaction
- HETEROGENEOUS CONSTRUCTION -- diversity of influences on the development of an idea or person that build on each other over time and provide multiple potential points of engagement
  R. Heterogeneous construction as a model of agency

Binder 7. DOCUMENTS related to Service and Institutional Development

The exhibits have been selected to illustrate the four sections discussed in Section III of my personal statement, plus some other material.
See Table of Contents

Contents pages for: Personal Statement | Portfolio | | Research and Writing-->

INTRODUCTION

(9/01)
As a young environmental and political activist in Australia in the 1970s I was involved in a wide range of actions--from working with trade unionists to oppose the construction of an inner city power plant through campaigning against excess packaging to establishing a natural foods co-operative. However, when someone asked me: "If you could wish for one thing to be changed when you wake up tomorrow, what would it be?" my answer was not a concrete political success or environmental improvement. I replied simply: "I would want everyone to question," by which I meant not to be merely sceptical, but to consider alternatives to accepted views and practices. This interest in critical thinking evolved in ways that led, many years later, to my appointment in the fall of 1998 to the second full-time faculty position in the Program in Critical and Creative Thinking (CCT) in the Graduate College of Education (GCOE) at UMass Boston (UMB).

When I look back at the path from Australia in the 1970s to CCT, I see that I was also moving in the direction of creative thinking. Where, we can ask, do a critical thinker's ideas about alternatives come from? Not out of individual inspiration, but from borrowing and connecting. The more items in your tool box--the more themes, heuristics (rules of thumb), and open questions you are working with--the more likely you are to make a new connection and see how things could be otherwise, that is, to be creative. Yet, in order to build up a set of tools that works for you, it is necessary to experiment, take risks, and reflect on the outcomes. Or--to use my current metaphor for critical and creative thinking--you have to journey into unfamiliar or unknown areas. This kind of journey involves risk, opens up questions, creates more experiences than can be integrated at first sight, requires support, and yields personal change.

This picture of critical and creative thinking makes a virtue of my chewing on many questions, exploring alternative practices, and accumulating diverse tools; of my relying less than many of my peers on established intellectual positions and institutional arrangements; and of my not following well-intentioned advice to get established in one field and use that as a base to seek a wider impact. My continued journeying has prepared me to present myself as a "work in progress" as I support others, following CCT's motto, to "develop reflective practice and change their schools, workplaces, and lives."

* * *

My research career started in Australia in ecology and agriculture, areas I was drawn to by my environmental and political activism. In 1980 I came to the United States for doctoral studies in ecology and evolution. During these last two decades my research and teaching have developed at intersections of the life and environmental sciences with the different disciplines that make up social studies of science and technology (STS)--history, philosophy, sociology, and politics of science. My dual position--as a scientist and interpreter of science--has helped me to steer clear of the not-so-helpful dichotomies of "Science as Truth" vs. "Science as a Reflection of Society." Instead I have examined specifically how the varied practical considerations faced by scientists translate into the particular ways they know the world and

pursue their scientific work. Whether in my science-STS classes or in research workshops with practicing scientists, my goal has been to stimulate people to interpret their particular social context in ways that further their own projects as learners, researchers, and social agents.

As I explored how to stimulate science students and scientists to consider the ways science takes shape within particular social contexts, I came to see that critical thinking and reflective practice were central to my intellectual and professional project. By this I mean that I lead students and scientists to contrast the paths taken in science, society, learning, and people's lives with other paths that might be taken. And I encourage them to bring the insights gained into their future studies and research. When I came across the announcement of a position in CCT with a speciality in "critical thinking in science and technology education," it looked like a wonderful opportunity to develop the project of bringing critical analysis to bear on the practice and applications of science. The context of teaching and working with a wide range of educators and other mid-career professionals would be conducive to addressing several new challenges:

> modeling reflective practice and make that compelling for science and STS audiences;
>
> presenting my specialty--scientific inquiry in its social context or "science-STS"--in ways that engage students and citizens in understanding science, especially in environmental studies (ES); and
>
> extending this work and building support through teaching and collaborating with educators--including my GCOE and other UMB colleagues.

In particular, I identified two new directions in my science-STS work:

> where before I had been teaching college students, I would work more with educators from K through college levels, and
>
> where the workshops I had led were with researchers who were already reflective, I would seek to address a wider group of scientists and citizens, especially those involved in debates about the social impact of science and in community-based research.

As it has turned out, my progress in these directions has been moderated by teaching and administrative responsibilities I assumed with the ill-health and extended medical leave since 1999 of the Program Director, Delores Gallo, the other core CCT faculty member in GCOE. Yet as some compensation for teaching less in my science-STS specialty area, more general CCT courses have given me the opportunity to develop skills in facilitating reflective practice. This has spilled over into my own practice--after all, if I want critical analysis to influence the process and applications of scientific research, institutional and personal change is needed, not only intellectual argument. As I knew from previous experience, my science-STS work would require new activities, directions, and collaborations within and around CCT, as well as collegial interactions across programs and disciplines. Moreover, not all of these initiatives could be expected to mature within the three years before tenure review. I certainly hoped that the institutional expectations for CCT and my work would be more settled than they have become during the 16 months since my receiving my positive 4th. year review. Yet, as with other challenges in institutional development, I have persisted in seeking ways to respond

constructively and take initiative.

In this spirit, my statement and accompanying materials convey not only my accomplishments, but also the ongoing self-assessment and development of research, teaching, and institutional development. The cross-fertilization among those three aspects of my work, which together I consider to be my scholarship, is also significant. Taken as a whole, this should give reviewers confidence that I will continue to be productive and innovative as a researcher, teacher, and colleague.

Contents pages for: Personal Statement | Portfolio | | Research and Writing-->

<--Introduction | | Contents pages for: Personal Statement | Portfolio | | Teaching & Advising-->

I. RESEARCH AND WRITING

(9/01)

I.A The Limits of Ecology

The centerpiece of my writing during my three years at UMB has been completion of a book manuscript, The Limits of Ecology and the Re/construction of Unruly Complexity, and related papers in critical thinking about ecological and socio-environmental research in its social context.[2] The manuscript, which synthesizes key elements of the research and publication I undertook before coming to UMB, was prepared under contract with the University of Chicago Press and submitted for review mid-July.

The case studies in The Limits are intended to stimulate readers' thinking in three broad areas: the study of complex ecological interactions; the interpretation of social influences shaping science; and efforts to feed interpretations of science back into changing scientific practice. In all three areas I explore the limitations of theories and models that treat complex situations as well-bounded systems that can be understood or managed from an outside vantage point. I propose instead that researchers take positions of engagement within "unruly" complexities that involve diverse components or agents and span a range of spatial and temporal scales. Knowledge production needs to be linked with planning for action and action itself in an ongoing process so that knowledge, plans, and action can be continually reassessed in response to developments--predicted and surprising alike.

The distinctive contribution I make in The Limits is to integrate conceptual, contextual, and reflexive angles on the practice of science and to explore rather than suppress the resulting complexity. I encourage people interested in various areas of ecology and socio-environmental research (ES), social studies of science and technology (STS), and critical thinking about science and ES to:

> expand their view of ES and STS research to include the interactions among researchers and other social agents to establish what counts as knowledge;
>
> locate such interactions as part of a larger endeavor in which ES and STS researchers pursue social change--however modest--and consequently
>
> address self-consciously the complexities of the situations studied andthe social situations that enable them to do their work; and
>
> appreciate the value of exploratory theorizing that may not solve immediate problems, but seeks a productive tension between established facts, theories, and practices and ideas about what else could be.

Many of the expository and conceptual moves I make to reach a multi-disciplinary audience are grounded in my science-STS classes and workshops. Although the integrated analysis in The Limits is built up through the case studies, I also introduce a series of puzzles, heuristic propositions, "tensions," and open questions. In the spirit of constructivism (in the educational sense of the term), these provide food for readers from various fields to chew on--I am not asking them to digest "the main course" in one sitting. One of the tensions that still animates my science-STS teaching is as follows.

My favored approach to STS is what I call "heterogeneous constructionism," that is, exposing the diverse "resources" researchers mobilize to establish knowledge--from funding opportunities to metaphors, from status hierarchies in their field to available sources of data. (This is a form of social constructionism--in the interpretive sense of the term--which is akin to actor-network theory but does not ascribe agency to non-humans.) In this kind of analysis, one has to address a wide array of relevant social agents, resources they mobilize, and possible points of engagement and reconstruction. Yet simple themes, such as "Population growth will lead to environmental degradation," are easier to communicate to a general audience than particular reconstructions of the complexity in environmental situations or in the social context of researchers. In that sense, such simple themes are resources that provide the basis for effective social mobilization--whether at the level of global environmental politics or, more modestly, at the level of teaching students and influencing colleagues. However, as I show in The Limits, simpler, more memorable, and adaptable accounts are only apparently simple. Their impact and importance depends on the ways they are linked to other resources by scientists and other agents who are negotiating how to contribute to changing knowledge, society, and ecology.

My response to the tension between developing complex accounts and invoking simple themes is to present situations or scenarios that are readily communicated yet, at the same time, point to the complexity is moved to the background in the attempt to communicate to others. For example, I often run a classroom simulation involving population growth in two islands--one with equal distribution of resources; the other with three unequal social classes. The theme or heuristic that emerges is that the analysis of causes and their implications can qualitatively change if equal units (of population) are replaced by unequal units (social classes) interconnected through various social, political, and economic dynamics. Such critical tensions or heuristics are intended to have broad application and open up important questions yet not require everyone to deal with particular cases whose detail only a specialists could absorb.[3] The need for further work on this approach and on other pedagogical, practical, and conceptual questions opened up by The Limits motivates the projects described in the section that follow.

I.B Concurrent and Prospective Educational Projects

It was important while completing The Limits also to explore the opportunities, needs, and constraints of my new location in an educational program and college. I present below the rationale, progress to date, and future plans for four projects that involve research, writing, and reflective practice in science-STS education. Deciding which will have priority for the coming years depends on as-yet-unresolved issues about the future institutional location, expectations, and workload for CCT and myself at UMB (see sects. III.D and IV).

I.B.1 Fostering Critically Reflective Practice, especially among Ecologists and Socio-Environmental Researchers

The Limits describes two pilot workshops from the late 1980s in which I led scientists to "map" their social context as it affected their study of ecological and environmental situations.[4] The goal was that participants would identify multiple potential sites of engagement and change for themselves, but this was only partially realized. This experience opened up questions about the kinds of reflection, dialogue, and workshop interaction that contribute most to scientists modifying the situations in which they undertake research. I have explored these questions since the mid-1990s through training in facilitation and group process, participation in interdisciplinary workshops, and experimentation in my own teaching and workshop leading (sect. II).[5] Although I am drawing on this experience in presentations that I will develop into publications,[6] my current plan is to pursue the questions primarily as applied scholarship, that is, to continue leading interdisciplinary workshops in ES and CCT/Reflective Practice and consulting on the development of interdisciplinary ES programs.

In a similar spirit, but with a different audience, I collaborated with CCT colleagues Nina Greenwald and Arthur Millman last fall to establish a Thinktank for Community College Critical Thinking Teachers. Subsequently I received a UMB Public Service Grant to continue the Thinktank and to construct a web-site of techniques and illustrative cases that CCT faculty and Thinktank members use to foster critical and creative thinking and reflective practice.[7] Teachers and College faculty will be encouraged to draw from the web-site for their own curriculum development and provide feedback towards eventual publication of a Thinking *for* Change Fieldbook.

I.B.2 Social Constructions of Life

Through teaching science-STS courses over the last decade I have generated extensive notes on almost thirty cases that introduce and illustrate: a) the use of "critical tensions" to promote understanding and critical thinking by placing established facts, theories, and practices in tension with alternatives; and b) the analysis of "heterogeneous construction," that is, of the diverse resources that scientists harness in establishing theories and in their work more generally. These cases cover selected historical and contemporary developments in the life and environmental sciences, ranging from accounts that invoke natural selection to support views about society to computer modeling of global climate change. The cases explore different connections between science and four strands of social life: scientists' use of language; their social/historical location; their political and economic interests; and their views of causality and responsibility. This "reciprocal animation" of science and interpretation of science breaks down the barriers between the natural sciences, the social sciences, and the humanities.

I plan to produce a text, Social Constructions of Life, and a web-site of associated pedagogical material to promote critical thinking about the reciprocal relationships between developments in the life sciences and changes in society. I intend the text and website combination both to reach a wider readership in biology and STS and to contribute to bringing STS into science education and science into liberal arts education. While completing The Limits I have kept this project moving by delivering presentations at conferences and workshops, completing publications for less specialized audiences,[8] and preparing two new cases.[9] My immediate plan is to complete a subset of the cases each time I have the opportunity to teach science-STS courses, revise them with student input, and make them available on a web-site[10] until I am ready to submit the text to a publisher.

I.B.3 Action Research on Science-STS teaching

From my experience teaching science-STS courses to college science students I believe that placing developments in science and technology in their social context can lead to deeper, more complex understanding and to more active inquiry not only in college science education, but also in high school education and in citizen involvement in scientific debates. To persuade other educators I need to disseminate cases and evaluate the conditions under which science-STS education can be successfully implemented. A necessary preliminary step in this project has to be connecting with college faculty and teachers willing to bring STS into their science and environmental curricula. With this end in mind, I convened a working group for teacher and faculty development in spring 1999 and have followed this with workshops each summer since.[11] (A seed grant for this was secured from STEMTEC, the Science, Technology, Engineering, Mathematics Teacher Education Collaborative of colleges and universities in Western Massachusetts.)

As it has turned out, college faculty members have been the main participants and, at that level, I am happy with my progress. I have been invited by the BioQuest curriculum development consortium to co-organize a biology-in-society component in BioQuest's annual 9-day faculty development workshop in June 2002. Last July I consulted with the relevant Program Officer at the Fund for the Improvement of Post-Secondary Education about submitting a proposal to host and evaluate further workshops--including, I hope, workshops with UMB science and general education faculty--and to disseminate in other ways cases, such as those from Social Constructions of Life. The workshops would also address methods for science-STS teaching and material on institutional change needed to support faculty in teaching innovation.

At the level of school education, however, it has been more difficult to establish a base for science-STS teaching. The number of trainee or in-service teachers studying in CCT or GCOE who focus on science at the middle or secondary levels is small and it will be a longterm project to recruit sizable cohorts (see sect. III). Recent changes in the Massachusetts Curriculum Frameworks and a heightened emphasis on testing have tended to inhibit curricular innovation. "Science, Technology and Human Affairs," which was one of the four dimensions of these Frameworks for Science, now appears only in an appendix and is not represented in the tests.

Against this background, I jumped at an opportunity to participate this last school year as co-PI and instructor in a Eisenhower Program course for middle or secondary-school math and science teachers, which promoted inquiry and problem-solving using watershed issues. The teachers produced exciting new units, but were very pragmatic about the changes they could find space and time for. The experience of this course taught me that I would need a longer-term and closer involvement with in-service teachers to encourage them to make use of my framework for critical thinking about the life and environmental sciences.

I now see a sustainable contribution at the K-12 level along lines similar to those of STEMTEC. By promoting "student-active" or inquiry-based approaches to undergraduate science education, STEMTEC hopes to stimulate more students to stay on science tracks and to see teaching as a worthwhile profession. STEMTEC efforts at the college level are designed to contribute indirectly to a much-needed increase in the number of K-12 science teachers. In the same spirit, although I am open to direct involvement in bringing science-STS into secondary schools, my current plan is to concentrate on science-STS curricular and faculty development at the college level.

I.B.4 The Study of Complex Interactions in the area of Environment, Health, and Society

To reach general audiences I use heuristics and themes for critical thinking with broad application (see end of sect. I.A above on The Limits). At the same time, however, I need to keep these in tension with the real-world complexities of specific scientific practice. To pursue questions opened up in The Limits I have begun to consider various ways complex interactions are studied in the area of environment and health. This shift to epidemiological cases from the research on rural and third-world situations considered in The Limits should facilitate day-to-day engagement with scientists and continue to make use of my skills in quantitative areas of science.

Before coming to UMB, I submitted a STS research proposal to NSF in the area of environment, health, and society. I was asked to make revisions, which I will have a chance to do this fall (using UMB Healy grant support) now that the book manuscript has been submitted. The NSF proposal concerns the intellectual history, current concerns, and reception of the fields of "gestational programming" and "life events and difficulties." These two cases allow me to bring more attention to the complexities of the concept "environment" and enrich discussion in this "Age of DNA" about environmental contributions to the development of behavioral and medical conditions over an individual's lifetime.[12] Through this study I also hope to find a suitable site and collaborators for specific research on the "heterogeneous construction" of epidemiological knowledge and policy and for continuing to link critical thinking with reflective practice in science.

Notes

[2] "Mapping complex social-natural processes" (1999), "What can agents do?' (1999), "Socio-ecological webs" (2000), "Distributed agency" (2001), "Whose trees are these?" (in press), "Situatedness and Problematic Boundaries" (in press), "Non-standard lessons" (in press), "Hidden Complexity" (under review). Publications and presentations that are abbreviated in these footnotes are given in full in my curriculum vitae. cited.

[3] "Non-standard lessons" (in press)

[4] "Mapping workshops" (1989) and "Mapping ecologists' ecologies" (1990).

[5] Workshop presentations: "Alternating between teacher and facilitator" (2000), "Critical Incidents in Teaching" (2000), "Building a Professional development Learning Community" (2000). Workshop facilitation: "How does nature speak?" (2000), "Helping Each Other..." (2000, 2001).

[6] "Process and product" (presentation, 2000), "Intersecting Processes and Reflexive Practitioners" (commentary, 2001), "We know more" (work in progress)

[8] "Natural selection" (1998), "How does the commons become tragic" (1998) reworked into "Non-standard lessons" (in press). See also the first sections of "Building on Construction" (1995) excerpted in "Distributed agency" (2001) and "How do we know?" (1997).

[9] "Genes, gestation" (work in progress)

[11] "Science-in-society, Society-in-science" (1999), "Helping each other..." (2000, 2001), "Teaching History, Philosophy, and Social Studies of Biology" (2001).

[12] "Genes, gestation" (work in progress)

<--Introduction | | Contents pages for: Personal Statement | Portfolio | | Teaching & Advising-->

<--Research & Writing | | Contents pages for: Personal Statement | Portfolio | | Service & Institutional Development-->

II. TEACHING AND ADVISING

(9/01)

II.A Wide Scope of My Teaching and its Active, Ongoing Development

One strength of my teaching lies in my willingness, in response to programmatic needs, to take on courses outside my specialty or without previous models and to learn from the experience of doing so. This learning is evident in the evolution of: the textual materials of my courses (syllabi, course packets, handouts, etc.); the course mechanics (use of email and websites, records kept to track each student's development, required conferences with students, etc.); and the teaching/learning interactions I establish.[13] My learning is also evident in the opportunities I have taken to get training and experience in experiential and problem-based learning, facilitation of group process, and leading faculty development workshops. Finally, my learning from teaching is evident in original contributions I have made to wider discussions about conceptual and pedagogical issues that have arisen.[14]

As a UMB professor I have taught eight different graduate courses: two in my specialty of science-STS (science in its social context); another two concerning computers and learning/education; and four required CCT courses. For seven of these I developed entirely new syllabi and in the other one (the co-taught "Critical Thinking" course, CCT601, Sp 99) I introduced many innovations. Two of the required CCT courses I have taught each year, giving me a chance to revise them in response to feedback and reflection, but the remaining courses I have taught once or for one year only. I have also originated and co-ordinated three special topics courses through Continuing Education to build up the CCT concentrations in science and in workplace and organizational change.

My Practitioner's Portfolio includes the syllabi and evaluations for each course and a section reviewing the initial goals, outcomes and changes made or planned. (This portfolio also addresses the request in my 4th. year review for "more extensive documentation of [my] teaching effectiveness.") In the sections that follow I include some general remarks on my teaching and advising as active and multifaceted processes, involving experimentation with and refinement of new tools and involving constant monitoring and steps to improve my practices. Many of the comments I make are further illustrated in the exhibits included in the Portfolio.

II.B The Philosophy of Teaching Critical Thinking I Brought to UMB

First, let me set the scene with an extract from a pre-UMB statement of my teaching philosophy:

> In a sense subscribed to by all teachers, critical thinking means that students are bright and engaged, ask questions, and think about the course materials until they understand

well established knowledge and competing approaches. This becomes more significant when students develop their own processes of active inquiry, which they can employ in new situations, beyond the bounds of our particular classes, indeed, beyond their time as students. My sense of critical thinking is, however, more specific; it depends on inquiry being informed by a strong sense of how things could be otherwise. I want students to see that they understand things better when they have placed established facts, theories, and practices in tension with alternatives. Critical thinking at this level should not depend on students rejecting conventional accounts, but they do have to move through uncertainty. Their knowledge is, at least for a time, destabilized; what has been established cannot be taken for granted. Students can no longer expect that if they just wait long enough the teacher will provide complete and tidy conclusions; instead they have to take a great deal of responsibility for their own learning. Anxieties inevitably arise for students when they have to respond to new situations knowing that the teacher will not act as the final arbiter of their success. A high level of critical thinking is possible when students explore such anxieties and gain the confidence to face uncertainty and ambiguity.

There are few models for teaching critical thinking, especially about science... Just as I expect of my students, I have experimented, taken risks, and through experience am building up a set of tools that work for me. Moreover, I have adapted these teaching tools to cope with the different ways that students in each class respond when I invite them to address alternatives and uncertainty, and when I require them to take more responsibility for learning.[15]

II.C Teaching Critical Thinking about Science in its Social Context

As indicated in the sect. I on Research and Writing, I believe that placing developments in science and technology in their social context can lead to deeper, more complex understanding and more active inquiry in college science education. I built two science-STS seminars concerning "Science in society" (CCT611, Sp 99) and "Environment, Science, and Society" (CCT640, Sp 01) as well as my section of "New Directions in Science Education" (CCT697, Sum 00) on the two complementary features below. To some extent the same themes informed "Thinking, Learning, and Computers" (CCT670, F98).

Reciprocal animation: Close examination of conceptual developments within the sciences can lead to questions about the social influences shaping scientists' work or its application, which, in turn, can lead to new questions and awareness of alternative approaches in those sciences. For example, although developments in computers are often promoted in terms of social or educational progress, historical and social analysis reveals the central role of military and, more recently, corporate objectives in determining which directions "progress" takes; and

Critical tensions: Theories and practices that have been accepted or taken for granted can be better understood by placing them in tension with what else could be, or could have been. For example, the "two islands" activity described in sect. I.A contrasts dominant models of global environmental change with those that emphasize the political and economic dynamics among unequal social agents. I intend students to add such "critical tensions" and heuristics to their own tool-box. I also introduce material that makes the tension clear between these simple critical thinking themes and accounts of "intersecting processes" that are more faithful to

complexity of particular situations.[16]

These courses extend my pre-UMB science-STS teaching so that students can address the course material not only as an opportunity to learn the scientific and interpretive content, but also as a source of pedagogical models for their own future teaching and as a basis for discussions about educational practice and philosophy. The content level still dominated in CCT611 and to some extent in CCT670, so when I taught CCT640 two years later I included activities that involved design of lesson plans and problem-based learning units and I encouraged curriculum course projects, not only research papers. This change was reasonably effective, but ironically the teachers in the course said they would have been happy to focus on stirring up their thinking and to leave lesson planning till later. Moreover, all the students in CCT640 expressed interest in reading a more complete exposition of my science-STS framework. I plan to continue the lesson design activities, but to make available for those interested my publications related to these features of my teaching[17] and the manuscript of The Limits of Ecology. Perhaps the appointment of Hannah Sevian to teach secondary science education might allow me to focus on the content level and make progress on the website and text described in sect. I.B.2.

II.D Leading Students from Critical Thinking to Taking Initiative

Traditionally critical thinking courses have emphasized scrutiny of assumptions, sources of evidence, and reasoning. Without alternatives in mind, however, scrutiny of one's own views or those of others proves difficult to motivate or carry out. As a teacher I have an ample supply of alternative views to include in readings and inject into discussions. Yet if students are going to take critical thinking beyond the cases introduced by me and their other teachers, they have to generate their own questions and explore issues that they were not aware they faced. This conundrum led me to start my first class teaching the Critical Thinking core course (CCT601, Sp 99) with a story about our place in space, a story that begins with a student's "aha..." experience and then turns the tables on myself.[18] I followed the story with a guided freewriting exercise and discussion to bring to the surface students' own insights about what allows people to see things in fresh ways. The factors that emerged were diverse--"relaxed frame of mind," "annoyed with this culture," "forgetting," "using a different vocabulary," and so on. This activity has not produced a general strategy for inducing independent critical thinking, but instead reinforces the challenge, shared by many areas of education, of acknowledging and mobilizing the diversity inherent in any group.

One aspect of the diversity among students is in their comfort with activities through which they explore and construct their own understanding. If students--especially adult learners who are returning to college after many years away--are anxious about what is expected of them, or if they feel under pressure to master a pre-defined set of skills, they might not have the experience needed for constructivist learning to happen. Early on in the same Critical Thinking course many students expressed dependency on my co-instructor, Arthur Millman, and me: "Aren't small group discussions an exercise in 'mutually shared ignorance'?" "Could the class be smaller?--we want more direct interaction with you." "I was never taught this at college; I'm not a critical thinking kind of person." Some asked for clear definitions of and procedures for critical thinking and for particular assignments and activities. This was most evident when they looked ahead to an end-of-semester "manifesto" assignment I had invented, which asked for "a synthesis of elements from the course selected and organized so as to inspire and inform your

efforts in extending critical thinking beyond the course." We responded to anxieties with some mini-lectures, handouts, and a sample manifesto, but we also persisted in conducting activities, promoting journaling, and assigning thought-pieces through which students might develop their own working approaches to critical thinking.

From mid-semester on, students who had been quiet or lacked confidence in their critical-thinking abilities started to articulate connections with their work as teachers and professionals. Although we had continued to reassure those who worried about the manifesto assignment that they would have something to say, we were surprised by how true that was. For example, the student who was not the "critical thinking kind" began her manifesto with perceptive advice: "If there is one basic rule to critical thinking that I, as a novice, have learned it is **DON'T BE AFRAID!**" She continued: "**Don't be afraid** to ask questions and test ideas, ponder and wonder... **Don't be afraid** to have a voice and use it!... **Don't be afraid** to consider other perspectives... Don't be afraid to utilize help..." She finished, "Above all, approach life as an explorer looking to capture all the information possible about the well known, little known and unknown and keep an open mind to what you uncover."

In retrospect, the students' confidence had begun to rise during classes involving various approaches to empathy and listening. This was an unusual emphasis for a course on critical thinking, and derives in part from my explorations in group process and facilitation. I suspect that listening well helps students tease out alternative views, and, in turn, being listened to well seems to help students access their intelligence--to bring to the surface, reevaluate, and articulate things they already know in some sense. The resulting knowledge is all the more powerful given that it is not externally dictated. I look forward to opportunities for more systematic exploration of the effects on critical thinking of listening and of being listened to.

After this course and other experiences during my first year teaching a diverse array of prospective teachers, experienced teachers, and other working, mature-age students in the CCT and other GCOE Programs, I started to speak of my model of teaching as "developmental." By this I meant that I aim not for a given final standard of work, but to guide and support each student to develop or improve as much as they can during a semester given their current, usually overburdened, circumstances.

A centerpiece of this developmental approach is what I call "dialogue around written work." For each class I require a journal and set a variety of written assignments, including steps towards a final project report. I make most of my comments on a cover page in which I show students their voice has been heard, reflect back to them where they were taking me, and make suggestions for how to clarify and extend the impact on readers of what was written. Then I ask students to revise and resubmit work--and I do so again if I judge that the interaction can still yield significant learning. This system departs from most students' expectations of "produce a product one time only and receive a grade" and pushes students' buttons about exposing their work to others. I have done several things to give this system a better chance of succeeding, which include: streamlining the set of requirements and grading rubric in my syllabi; including notes on "Teaching/Learning Interactions" in syllabi or as part of a course packet; and requiring at least two student-teacher conferences so concerns can be explored face-to-face before resistance sets in.

I also used the opportunity of a Fall 1999 faculty seminar to do teacher research[19] on improving students' experience of dialogue around written work in the not-so-accurately named "Practicum" (CCT698)--in reality a course on "processes of research and engagement" (which has become its subtitle). The surveys completed by students and subsequent

discussions produced a more general formulation of the challenge facing students in taking themselves seriously as lifelong learners: "[you need to] take initiative in building horizontal relationships, in negotiating power / standards, in acknowledging that affect is involved in what you're doing and not doing (and in how others respond to that), in clearing away distractions from other sources (present & past) so you can be here now" (from an email to students near the end of that semester). This formulation has helped me articulate a clear set of product goals and another set of process goals for the Practicum course and for the CCT experience as a whole.

The tensions among the different parts of the formulation are significant. For example, "building horizontal relationships" is about reducing the emphasis on the "vertical" one between professor and student, but "negotiating power / standards" recognizes that students make assumptions, for example, that my ultimate power over grades means that they should treat my comments on their work as instructions. Keeping such tensions in mind has helped me to anticipate students' running hot and cold in their work and to patiently persist in supporting each student making the shift from dependent to self-constructed or self-affirming learning. The time available or other conditions are not always conducive to this shift, which I address in the next section.

II.E Learning from Difficult Courses in a Thoughtful, Respectful, and Professional Manner

In light of the previous section, I expect teaching every student to be a challenge. Listening well, extended dialogue around written work, and a developmental model imply, even in large classes, an individualized model of teacher-student interaction. Students' expectations are often raised and not easy to fulfill within the time constraints of UMB students' work schedules and of my preparing new courses. I have learned how important it is to make time for student contact immediately before and after classes and to take more risks to address students who avoid dialogue around their work and my expectations. This has sometimes proved difficult.

In two courses--the "Synthesis seminar" (CC695, F 99) and "Computers, Technology and Education" (Ed610, Sp 01)--dissatisfaction was evident in the student evaluations. During those courses I became aware that many students were not engaging actively in the range of teaching / learning interactions laid out in the syllabi. In particular, few were revising significantly in response to comments and did not seem comfortable with my expectation of self-constructed learning--learning new ways to learn--out of class. I discovered that students had strong preconceptions that the syllabus would be tightly focused, respectively, on copy-editing to produce a finished synthesis paper and on hands on use of computers. I responded thoughtfully, respectfully, and professionally to students' criticisms, made adjustments where possible during the semester, initiated class discussions on the challenges of teaching such courses, and spent considerable time planning the future syllabus. In both cases, my reworking has not taken the safe path of conforming to the students' preconceptions, but rather attempts to ease future students into my pedagogy through more explicit scaffolding. The second offering of the Synthesis seminar (CCT694, Sp 00) succeeded in engaging the students on more levels; time will tell if I capture the hearts and minds of Teacher Ed. students in Ed610 this fall.

"Time" is relevant in several other ways. The first occasion I taught both these "difficult" courses I took them on at short notice as additions to my expected workload and without knowing that students had been advised to expect something different from what I planned.

Time did not permit me to reinvent the syllabus in midstream, nor to chase up and check-in with enough of the students who were only minimally addressing the course expectations. These situations called for more communication and dialogue than usual and it was most distressing to have competing responsibilities limit time needed for this. In retrospect, I see that I had been fortunate in the course described in the previous section that a semester was sufficient for students to shift their position as learners--a semester is somewhat arbitrary length of time in this respect. One student in the Computers in Education course, for example, was adamant at first that she needed to learn to use a computer before she could evaluate their use in education. Then, for family reasons, she had to take an incomplete. With the extra time to develop her final project report, she came to insist on a "health skepticism regarding the push and 'promises' of technology" and on the need to emphasize "better teaching, rather than simply 'mastering technology'."

Even in courses that work well, it is important to take into account the "life course" of students' learning. The early stages of my courses, including the requirements and early assignments, seem to some students to be "ambiguous." This characterization has led me to clarify my instructions in response to specific questions and suggestions--sometimes elaborating, sometimes streamlining--to re-order classes, and to redesign activities. Yet, I do not assume that fine-tuning and being more explicit will completely eliminate feelings of "ambiguity." Such feelings can be read as a way students made sense of the early parts of the semester when they were less confident in their own thinking. According to the developmental model, if I patiently encourage students to reflect in their journals, submit thought-pieces, and revise in response to comments, they usually weave together the strands and end up with a stronger sense of making the course material their own. Evidence for this can be seen, for example, when, during a "historical scan" at the end of "Thinking, Learning, and Computers" (CCT670, F 98), students divided the course into two phases and suggested the names "Big Bang" (for all the new issues that were introduced in the first half) and "Realizations" (for ways that the issues came together for them in the second half). (These two phases recall my introductory picture of critical and creative thinking as involving more experiences being had than can be integrated at first sight as well as the idea in sect. I.A of knowledge-making as construction from heterogeneous resources.)

I have an advantage over three years ago in teaching CCT students, namely, that many have done previous courses with me, or at least have been advised by fellow students or myself about the style of the course. To further help students get into the swing of things, I sometimes invite alums of the course back to be interviewed by the next class and I make syllabi, course evaluations, and my portfolio available for perusal on the web. Despite testimonials to the impact of my teaching, I still see it very much as a "work in progress." Indeed, I model what I expect of my students, that is, to experiment, take risks, adjust plans, and through experience and reflection build up a set of tools that work for oneself. This does not play well to all adult learners, especially when they are pragmatic about what they can and need to accomplish in their limited time left after work and their other responsibilities. I expect to have to continue to address the tension between, on one hand, the CCT ideal of students taking initiative and becoming reflective practitioners and, on the other hand, the risk of losing students who come to class, or to the course as a whole, un(der)prepared to engage for themselves and more comfortable when the important lessons are didactically presented.

II.F Learning from Educators beyond CCT

The move of CCT into GCOE and my location there raised the challenge of adjusting CCT courses to complement offerings in other the M.Ed. and doctoral programs and meet the needs of students outside CCT, including educationally-oriented students in Science departments. I mentioned above the curriculum development strand of my science-STS courses (sect. II.C) and efforts to support a wide range of students in critical thinking and in taking initiative as learners (sect. II.D). I have also discussed with some Leadership in Education faculty members the possibility of some doctoral students joining the Practicum course to help them shape their research projects, and I am taking preparatory steps for this same course to be offered with a large distance or online learning component. The area of cross-program linkage, however, that I have explored the most is in action- or practitioner-research. Drawing from Lee Teitel's courses in the Ed. Admin. program, the "Evaluation of Educational Change" (CCT685/693) now positions evaluation not an end in itself, but as a tool of educational change--or, for the non-educators in CCT, of organizational change. Students learn and practice tools for facilitating groups and building constituencies for the educational changes the students want to evaluate or propose.

My learning from others and the connections I have made in the action- or practitioner-research direction have enabled me to bring into being the long-planned concentration in CCT in the workplace (sect. III.C). It also shaped my contribution this last year as a co-PI and instructor in a Eisenhower Program course for math and science teachers (sect. I.B.3). This course promoted inquiry and problem-solving about environmental issues, which gave me a chance to work with teachers in my speciality science-STS area. However, it turned out the most important role I could play was to facilitate the teachers' professional development planning and teacher-research. This role gave me space to be more of a student when it came to learning about the constellation of factors that teachers face in classrooms and in school systems when they consider changing their teaching. As mentioned earlier, I see the need for longer-term and closer involvement with in-service teachers to influence and support change in the areas I know best.

II.G Promoting Collegial Interaction Around Innovation in Teaching

Educational change is not only an issue in K-12 schools, but also in higher education. Academics need, I have long believed, the same level of sustained collegial give-and-take, collaboration, critique, and mentorship that we value around research and writing. While at UMB I have put this belief into practice in several ways: participating in a faculty seminar in 1999 and leading workshops hosted by the Center for Improvement in Teaching; organizing faculty development workshops and the Thinktank on fostering critical thinking in which participants could connect theoretical, pedagogical, practical, political, and personal aspects of their work; and making contributions towards new models of documentation and evaluation of teaching.

In this last area my philosophy is that every process in an educational institution can be a teaching/learning interaction, an opportunity for all parties both to teach and to learn from each other. The forms of spoken and written evaluations I use in my courses supplement the official "bubble" sheets, taking wider goals and audiences into account, namely: to guide instructors in continuing to develop the course; to guide future students in choosing courses and knowing what to expect; and to allow current students to take stock of how to get the most from courses and teachers in the future. In the same spirit, I have prepared a Practitioner's Portfolio to accompany this statement. I welcome dialogue around the Portfolio's different

components with the idea that this could help readers appreciate work in areas or directions unfamiliar to them and could help my CCT and GCOE colleagues clarify and revise their assessments, goals, and expectations. Whether or not dialogue and the Portfolio can be fully integrated into a formal review at this time, I hope the materials I am submitting contribute to the evolution of future reviews that are genuine two-way teaching/learning processes.

Notes

[13] Practitioner's Portfolio, "Key teaching/learning tools"

[14] "From 'dialogue around written work' to 'taking initiative'" (report, /citreport.html); "Notes towards guidelines about specific situations and specific ways in which specific technologies are of significant pedagogical benefit"; "We know more" (work in progress)

[15] "Teaching Philosophy" (1995)

[16] "Distributed agency" (2001)

[17] "The social analysis of ecological change" (1995), "What can agents do?" (1999), and publications listed in note 8.

[18] "We know more" (work in progress)

[19] "From 'dialogue around written work' to 'taking initiative'"

<--Research & Writing | | Contents pages for: Personal Statement | Portfolio | | Service & Institutional Development-->

<--Research & Writing | | Contents pages for: Personal Statement | Portfolio | | Institutional Need-->

III. SERVICE AND INSTITUTIONAL DEVELOPMENT

(9 / 01)

I have addressed the expectation of service to the institution and wider community in the broad sense of collaborating with colleagues to respond to the challenges we face working in UMB and allied institutions. The strength of my contributions lies in taking initiative to identify challenges and in innovating so as to make effective use of limited resources. In this section I discuss four major challenges I have addressed. This should be read in conjunction with details presented in my Annual Faculty Reviews (AFRs) and recognition that below the radar screen of AFRs lie many day-to-day initiatives, such as designing a spreadsheet soon after I arrived that my department used to process its backlog of course evaluations.

III.A Building a Basis for Interdisciplinary Science and Environmental Education

The contribution of GCOE to Science Education is an important issue, not the least because of the shortfall in qualified science teachers in Massachusetts. During my first year at UMB I became acquainted with the range of funded centers and initiatives in Science Education in Massachusetts. It became clear that preliminary steps were needed before GCOE would be in a position to compete for funds with the more established programs. The steps that I have been involved in include: establishing a science track within the M.Ed. program; connecting with CAS departments around this track or an Master of Science in Teaching (MST) degree; a CCT certificate in "Science, Education and Society"; a summer "New Directions in Science Education" course (to recruit new students and address the need for secondary science education courses); preparation of GCOE's science education folio towards national accreditation; and a search for a secondary science education faculty member who could teach core courses and take a leadership role. I look forward to supporting the new appointee, Hannah Sevian, in the directions she takes to continue building Science Education at UMB.

Notwithstanding the other centers and initiatives in the state, there appeared to be a distinctive niche for contributing in the science-STS area. As Steve Fifield remarked in his evaluation of the summer practitioners' workshop I organized in 1999: "The standards movement has a tendency to be interpreted as a push toward 'the basics' (i.e., decontextualized facts and concepts), but it is important to make clear that the study of science in social context is a component of national reforms and most state standards" and to identify allies and support teachers in "their attempts to broaden the meaning of science education." As mentioned in the introduction, the idea that critical analysis of science can influence its practice and application is not well developed or supported institutionally, and so new collaborations, programs, and other activities--or new directions for existing programs--are needed. My work in interdisciplinary science and environmental studies has involved many collaborations across disciplinary, institutional, and national boundaries.

The most significant venue for me outside my formal appointments has been in the International Society for History, Philosophy and Social Studies of Biology (ISHPSSB). In its biennial summer meetings the ISHPSSB brings together scholars from diverse disciplines, including the life sciences and history, philosophy and social studies of science. I served on the Executive from 1993-99 as President-elect, President, and then past-President. My earlier contributions, however, on the program committee (1987-89) and as program organizer (1989-91), were equally significant. It was during this period that the society was being formalized, and I worked hard to ensure that institutionalization did not undermine the tradition of innovative, cross-disciplinary sessions and discussions. I have personally organized sets of sessions at almost all of the ISHPSSB meetings, many of which have led to special editions of journals and one book.[21]

My recent service outside UMB has focused on teacher and faculty professional development and new interdisciplinary programs. In addition to the Eisenhower Professional Development course for teachers described in sect. I.B.3, I established within ISHPSSB a Committee on Education with a website to link ISHPSSB members to current initiatives concerning the teaching of science in its social context. This summer I organized the first of what are planned to be regular pre-conference workshops. The "Changing Life" working

group (Sp 99) was a local initiative in the same direction, and this has evolved into summer faculty development workshops (sect. I.B.3). I am now collaborating with Prof. Fifield from U. Delaware to co-organize a biology-in-society component in BioQuest's annual 9-day faculty development workshop in June 2002.

In November 1998 I served as a consultant on the plans for a new interdisciplinary environmental studies doctoral program at the National Autonomous University in Mexico (UNAM) and since then have been consulted or participated in several boundary-crossing initiatives. In recognition of my ability to make trans-disciplinary connections, I have been invited to give commentaries in areas ranging from methodology in studies of communication to the use of remore sensing techniques in geography.

III.B Ensuring a Viable CCT Program without the Other Full-time CCT faculty Member

After a number of years with only one full-time faculty member in CCT, my appointment promised to make possible a sharing of the burden of administration, recruitment, advising, and thesis / synthesis supervision as well as outreach and program development projects. Unfortunately, by the end of my first year at UMB the Program Director, Delores Gallo, had reduced her time on campus for health reasons and then began what has turned out to be an extended medical leave. By a concerted effort she had cleared the backlog of students needing only to complete their theses and synthesis projects, but she was behind in record-keeping and other administrative projects.

My response to the challenge of taking on the program directorship under these circumstances has involved--in addition to the routine duties of this position--three main strands (see table below). Each of these has required a considerable "up-front" investment in the hope of making recruitment, advising, and other administrative tasks (such as preparing for program reviews) less consuming of time and attention. "Less" is relative not absolute, however, given a number of features of CCT: the absence of a standard conduit for students into the Program; the diverse interests and concerns of those admitted; the intensive seminar / workshop / activity format of CCT courses; and the syn / thesis requirement for completing the Program. The success of these efforts may be seen in the 26 new students already admitted for fall 2001 (the target given CCT was 21-25 for the full year), all recruited in a period after the elimination of the course release for a Program Director. However, given the unsustainable workload and stress, I hope the day comes soon when the running of CCT can be shared between two core faculty members.

Goal	Examples of measures I have undertaken or led
Enhanced advising & office procedures	Advising -- Student handbook; Revived CCT website; Publicity brochures; Regularized roster of course offerings; Handbook on synthesis projects; Guidelines re: incompletes and passage through program requirements; Exit self-assessment Administration -- Enhanced and updated program database; Office operations manual; Application review procedures & tracking system; Working bees to sort CCT materials in storage
More "horizontal" exchanges and support within and beyond the community of CCT	CCT in Practice (weekly presentations in F 00 and F 01 and full-day open houses); bi-weekly email newsletter; CCT Community directory; Recruitment drives; Links through ASCD

students & alums organizations;	Teaching Thinking network and other allied
	Orientation and Community gathering (F 01)
CCT faculty outside GCOE business	Monthly meetings focusing on interests other than
and adjuncts engaged in plan	(spr. 99); Preparation of talking points and AQUAD
development of the program Workplace	(99-00); Planning for outreach unit;23 CCT in the
& creating a wider impact conjunction	courses (Sum 00-) and new certificate Options in
	with Continuing Education; Thinktank for community
college	
	teachers of critical thinking (F00-); Thinking for
Change	
	Fieldbook (Sum 01-)24; Preparation for initiative on diversity in CCT (Sp 01-)

III.C Developing CCT in New Directions

Traditionally, CCT courses and workshops have covered "psychological studies of... critical and creative thought...; philosophical studies... in reasoning, argument, logical thinking, valuing, and judging; and work with cognitive structures and metacognitive techniques for stimulating creativity and critical thought." At the same time, social justice concerns have motivated the educational and social change work of many CCT students and faculty. This spirit has informed my efforts to develop a science-STS component to the math. and science concentration in CCT and associated outreach (sect. III.A). I have only been able to offer two science-STS seminars (sect. II.C), but plan to continue promoting this area of CCT, whose growth should benefit if the different proposals for an M. Ed. science track, MST, or combined environmental science / education degree go ahead.

Once I began directing the program I became aware of previous attempts to expand CCT in the area of critical and creative thinking in the workplace. Building on my own interest in reflective practice, I have organized a suite of three courses through Continuing Education that can be taken on their own or as part of a version of the CCT Certificate with the theme, "Dialogue and Collaboration in Organizational Change." These courses are proving popular and have led a number of students to apply to or transfer into CCT.

Another challenge for CCT has been to address the 1994-95 review committee's recommendation to present a higher profile, within the university and in the wider community, for what is distinctive about CCT's work. The AQUAD plan produced by the Program in spring 2000 laid out some steps that seemed possible despite the reduction of resources for the Program since the mid-90s review. Of these, I have been involved in: presentations for C.I.T.; arranging CCT in Practice sessions open to the public; the Thinktank for community college teachers of critical thinking (which received a UMB Public Service grant); promoting the new Graduate Certificates and associated non-credit workshops; and groundwork for a plan to increase the social diversity of CCT students and for CCT courses to address the issues of increasing diversity. In addition, students from CCT693 last spring developed proposals for CCT to support more internships and practical experiences giving students a chance to apply what they are learning in their courses. I look forward to collaborating with other CCT faculty members in such directions as we prepare for the next Program review scheduled for 2002-3.

III.D Clarifying and Strengthening CCT's Status in GCOE

I discussed with Dean Clark before accepting his offer of appointment how the status of CCT in GCOE needed clarification. GCOE had then only recently become CCT's home college and all but two of the CCT faculty still resided in the College of Arts and Sciences. The challenge was for GCOE to articulate a positive place in its educational mission for the kind of mid-career personal and professional development pursued by CCT Masters students and to address the particularities of CCT as an interdisciplinary, inter-college Program. Clear parameters were needed to allow CCT faculty to plan the best use of their experience and energies. For myself in particular, appropriate criteria and procedures for review of interdisciplinary CCT work needed to be agreed on.

These concerns motivated CCT faculty to prepare a series of requests and proposals in 1999-2000, to which, unfortunately, no explicit response was received. From my side, I sought increased collaboration between CCT and other GCOE programs by, for example, drawing others into the CCT in Practice sessions, participating in math. and science education initiatives, making connections among faculty members involved in action-research and research preparation courses, and hosting an orientation to CCT. Yet, as I learned after my 4th. year review, GCOE leaders still saw CCT as marginal or even outside their vision of the College. It was felt that CCT faculty needed to serve GCOE more directly. In response, I took on key GCOE tasks beyond the CCT Program and Department of Curriculum and Instruction (C&I; formerly S.O.C.I.). (In particular, I have been active in the Dean's Technology Task Force and I chair the Academic Affairs and Curriculum Committee, in which role I clarified and publicized procedures for course and program change proposals.) Nevertheless, after the last year of different proposals and shifting expectations (summarized in the section to follow), noone could claim that the status of CCT in GCOE is yet clear or strong.

Notes

[21] "Pictorial representation in biology" (1991); "Science studies" (1994-5); "Ecological visionaries" (1997); Changing Life (1997), "Natural Contradictions" (1998); "Philosophies of Ecological Science" (2000).

<--Research & Writing | | Contents pages for: Personal Statement | Portfolio | | Institutional Need-->

<--Service & Institutional Development | | Contents pages for: Personal Statement | Portfolio

IV. INSTITUTIONAL NEED

(9/01)

Since I received my 4th. year review 16 months ago, which gave a strong endorsement of my CCT-based work, questions have been raised about the institutional location, mission, and even survival of CCT. Although I would have preferred a stable context for my work, I have responded constructively and taken initiative in ways that the following table summarizes.

Expectation/Proposal	Examples of My Response
To be accepted as part of GCOE, CCT faculty need to serve on GCOE committees and in Leadership; since other GCOE programs (Acting GCOE Dean, May '00) I have Educational professional NCATE	I volunteered to serve on doctoral committees in Educational Sept. '00 I have chaired the GCOE Affairs & Curriculum Committee; and taken an active role in GCOE's Technology planning and development as preparation for accreditation.
GCOE Programs will be more tightly subsumed within Departments. Programs will be run by the Departmental Chairs so the Program mission. Director positions can be abolished (GCOE Operations Dean, September '00) handle supervision.	CCT faculty prepared a proposal on Leadership in Education as the GCOE Department that best matched CCT's At the same time, I prepared an Manual so Graduate Assistants could administrative tasks with less I took on an additional course in the spring for the Teacher Ed. program.
I should serve GCOE's teacher education mission as a "science content specialist" to strengthen links between GCOE and CAS science faculty (GCOE Dean, November '00)	In addition to the Eisenhower Professional Development course I was already involved in, I participated in Title II meetings and made initial connections with Science supervisers in BPS.
The CCT Program may be phased out. I should cover the required courses and advising	I began to learn about the Teacher-Research component of the Teacher Ed.

Program as a until current students have graduated (GCOE required Dean, January '01)	place to translate what I teach in CCT courses.
CCT needs a cohort of 25 new students for any applicants to be admitted (C&I Chair, students February '01) deferred more	My recruitment efforts (with Nina Greenwald's assistance) yielded 26 admitted for the Fall with 5 more from previous admission cycles, and strong applications in process.
CCT and my line should move to CAS and serve CAS the General Ed. program (GCOE Dean, my Fall April/May '01) experienced might equivalent Spring '02	I discussed General Ed. needs with Deans. I then changed the theme of '01 Critical Thinking seminar to Quantitative Reasoning so graduate students from that course qualify as teachers for an undergraduate QR seminar in the and beyond.

My ability to adapt to change and uncertainty in institutional need is evident in this table and in the earlier sections of this statement. Let me affirm, however, that my ideal is to continue the scholarly development described in this statement and serve UMB from a base in CCT, which would continue as an innovative graduate program for mid-career teachers and other educators as well as for leaders or change-agents in other kinds of organizations.

At this point the CCT Program remains housed in the GCOE in the Department of Curriculum and Instruction (C&I) and so for the purposes of this tenure review I would like to assume that the mission of the CCT Program will be seen as part of--not apart from--the educational mission of C&I and GCOE. The materials I and others are submitting should document contributions and an impact beyond my primary responsibilities in the CCT Program. Nevertheless, my hope is that formal changes in expectations for CCT and thus for my work at UMB will be left as a matter for consultation with the full CCT faculty after my tenure decision. Anyhow, whatever emerges from these processes of review and institutional change, I look forward, as long as I am involved in public education, to continue learning about how to secure space and support for critical thinking and reflective practice, especially about environment, science and society.

<--Service & Institutional Development | | Contents pages for: Personal Statement | Portfolio

CURRICULUM VITAE

Peter Taylor

Associate Professor and Faculty Advisor
Program in Critical & Creative Thinking
Department of Curriculum & Instruction, Graduate College of Education
University of Masachusetts, Boston, MA 02125, USA

617-287-7636 (o); 7664 (fax); Email: peter.taylor@umb.edu
WorldWideWeb Site: http://omega.cc.umb.edu/~ptaylor

AREAS OF RESEARCH AND TEACHING

Critical thinking and Reflective Practice, especially about Environment, Science, and Society
Science, Technology and Society
Social Analysis of Ecological Change
Theoretical Ecology

EDUCATION

Ph.D., Organismic & Evolutionary Biology, Harvard University, 1985
Dissertation: "Construction and turnover in multispecies communities: A critique of approaches to ecological complexity"

B.Sc.(Hons.), Monash University, Australia, 1975
Majors in Biomathematics and Zoology

POSITIONS HELD

Adjunct Professor, Department of Environmental, Coastal and Ocean Sciences, 2002-

Assistant Professor, Acting Program Director and Faculty Advisor
Program in Critical & Creative Thinking, University of Masachusetts Boston, 1998-2002

Eugene Lang Visiting Professor for Social Change, Swarthmore College, 1997-98

Rockefeller Fellow, Rutgers University, Center for the Critical Analysis of Contemporary Culture, 1996-97

Assistant Professor, Cornell University, Program on Science, Technology & Society 1990-91; Department of Science & Technology Studies, 1991-97

Research Collaborator, Grupo de Estudios sobre Instituciones Agrarias y Recursos Ambientales, Departamento de Economía, Centro de Investigación y Docencia Económicas, Mexico, 1992-97

Visiting Professor, Centro de Investigación y Docencia Económicas and Centro de Ecología, U.N.A.M., Mexico, 1992, 1993

Senior Ecologist, Biosystems Analysis, Tiburon, CA, 1989-90

Wantrup Fellow in Natural Resource Economics, University of California, Berkeley, 1987-89

Guest Lecturer, University of Helsinki & Academy of Finland, 1988

Research Associate, Museum of Comparative Zoology, Harvard University, 1985-87

Faculty, New School for Social Research, Lang College Science, Technology and Power Program, 1986-87

Teaching faculty, Harvard University Summer School, 1986-87

Mellon Fellow, Science, Technology & Society, M.I.T., 1985-86

Teaching fellow and tutor, Harvard University, Biology, History of Science and the Core Curriculum, 1981-85

Summer Research Associate, Environmental Sciences Division, Oak Ridge National Laboratory, Tennessee, 1984

Course development consultant, Royal Melbourne Institute of Technology, Australia, Socio-environmental assessment program, 1982

Marine Ecosystems Research Group, Harvard School of Public Health, 1980-82

Graduate Research Assistant, Institute of Applied Economic and Social Research, University of Melbourne, Australia, 1978-79

Senior Research Assistant, Agriculture Dept., University of Queensland, 1976-77

Tutor, Monash University, Australia, Statistics, 1975

TEACHING and ADVISING

University of Massachusetts, Boston
Thinking, Learning and Computers
Practicum: Processes of Research and Engagement
Critical Thinking
Science-in-society [Seminar in Critical Thinking]
Evaluation of Educational Change
Synthesis of Theory and Practice
Computers, Technology and Education
Environment, Science, and Society [Critical and Creative Thinking in Science and Technology]
Making Sense of Numbers [Seminar in Critical Thinking]

Cornell University
(See also links on website to statement and portfolio describing this teaching.)
Biology and Society: The Social Construction of Life
Social Analysis of Ecological Change
Investigative Research on the Social Impact of Science
Statistical Analysis for the Life Sciences
Science and Social Theory (Themes: Structure & agency; Changing ideas of nature)
Ecology and Social Change (Freshman writing seminar)
Visualizing the Dynamics of Science

GRANTS, FELLOWSHIPS & AWARDS

Visiting Scholar, Pembroke Center for Teaching and Research on Women, Brown University, 2002-03.

Instructional Technology Center, Senior Fellowship, University of Massachusetts Boston, 2002.

Public Service grant, University of Massachusetts Boston, 2001.

Healy grant for Proposal Development, University of Massachusetts Boston, 2000.

Faculty Seminar Participant, Center for Improvement of Teaching, University of Massachusetts Boston, 1999.

STEMTEC grant for Science in Society workshops, 1999.

Visiting Fellowship, Agrarian Studies Program, Yale University, 1998 (declined)

PROFESSIONAL ACTIVITIES

University of Massachusetts, Boston:

Program Director, Critical & Creative Thinking Graduate Program, 1999-2001; Faculty Advisor, 2001-
Environmental Council, 2002-
Chancellor's Committee on Sustainability, Chair, Sub-committee on "Infusing Sustainability into the Curriculum," 2002-
Search Committee for Science Education position, 2001
Organizer of "Critical and Creative Thinking in the Workplace" Workshops/Course, 2001
College Academic Affairs & Curriculum Committee, Chair 2000-
College MEET Educational Technology Fellow, 2001-2
Dean's Task Force on Educational Technology, 2000-
Provost's Task Force on Environmental Affairs, 2000
Committee to establish General Science Degree, 1999
Departmental Personnel Committee, 1998-99, Chair 1999
Committee to establish M.Ed. in Science & Math. Teaching, 1998-99
Admissions Committee, Critical & Creative Thinking Program, 1998-
Advisory Board of Program in Science, Technology, and Values, 1998-
Organizer of "Critical and Creative Thinking in Practice" Forum and Workshops, 1999-
Organizer/leader of workshops, "Science-in-Society, Society-in-science," "Helping Each Other to Foster Critical Thinking about Biology and Society," "New Directions in Science Education," "Helping Each Other to Foster Critical Thinking about Environment, Science, and Society," 1998-

Beyond the Campus:

(See also links on website to 2001 statement describing these activities.)
Pembroke Center Seminar on Theories of Embodiment, Brown University: Workshop leader, December 2002.

Society for Social Studies of Science: Organizer of sessions "Social interactions in the production of epidemiology," 2002; "Ecological politics as cultural discourse," 1998.

Handbook of Ecological Concepts, Invited international workshop participant, 2002

External reviewer, Centre for Social Studies at the University of Coimbra, Portugal, 2002

Massachusetts Board of Higher Education and the Dwight D. Eisenhower Professional Development Program in the South River/South Coastal Watershed, Co-PI 2000-1 and Workshop Leader, "Building a Professional Development Learning Community," November 2000 and "Developing Unit Plans for Inquiry- and Problem-based Learning," May 2001.

International Society for History, Philosophy and Social Studies of Biology:
Past-President, 1997-99
Education Committee, Chair, 1997-2001; Member 2001-
Organizer or co-organizer of sessions "Genes, Gestation, and Life Experiences: Perspectives on the Social Environment in the Age of DNA" in 1999; "Teaching History, Philosophy, and Social Studies of Biology" pre-conference workshop in 2001.

Association for Supervision and Curriculum Development, Panel Member, "Teaching Thinking: Looking Backwards, Looking Forwards," March 2001; Teaching for Thinking Network Board member 2001-.

NSF Workshop on a Research Agenda for Linking Ecological and Economic Systems, Tempe, Invited Participant, June 2000.

University of Tampere, Finland, International Collaborator in the "How does nature speak?" project, 1996-; Workshop facilitator, 2000.

Local Knowledge and Global Consequences Workshop, Harvard School of Government, Invited Commentator, April 2000.

National Center for Ecological Analysis and Synthesis, Workshop on "Rethinking the Human-Nature Boundary," Invited participant, March 2000.

BioQuest workshop on Teaching College Biology, Invited Presenter and Participant, June 1999.

Massachusetts Board of Higher Education, Honors Faculty Development Workshop, Invited Workshop Leader, June 1999.

"Changing Life" (working group on fostering critical thinking about life and environmental sciences); Convenor, 1999

Centro Regional de Investigaciones Multidisciplinarias, U.N.A.M., México: Consultant and Commentator on development of doctoral program in "Society, Enviroment, and Sustainability," November 1998.

Swarthmore College: convenor of study group, "New biology: Old and new questions," 1997-98; organizer, international workshop, "How can we help each other with 'agency'?," April 1998.

Columbia University, member of University Seminar on "Ecology and Culture," 1997-98.

Science as Culture, editorial board, 1997-; guest co-editor for special edition on "Ecological science and Environmental Politics," 1997-98.

Reviewer:
Science as Culture; Science, Technology & Human Values; Social Studies of Science; Society and Natural Resources
Harvard University Press; Routledge; SUNY Press; MIT Press; University of Colorado Press
International Conference on System Sciences

Membership in Professional Societies:
Ecological Society of America
International Society for History, Philosophy and Social Studies of Biology
Society for Social Studies of Science

PUBLICATIONS

Abstracts can be viewed for many papers; full text versions are linked to abstracts for some.
(* indicates primary author/editor other than PJT; # indicates equal joint authorship/ editorship)

Books

Changing Life: Genomes, Ecologies, Bodies, Commodities Minneapolis: University of Minnesota Press (ed. with S. Halfon & P. Edwards), 1997.

Articles

"Situatedness and Problematic Boundaries: Conceptualizing Life's Complex Ecological Context," Biology & Philosophy, 16 (4), 521-532, 2001. (with Y. Haila).

"The Philosophical dullness of classical ecology, and a Levinsian alternative," Biology & Philosophy, 16 (1), 93-102, 2001. (with Y. Haila*)

"Socio-ecological webs and sites of sociality : Levins' strategy of model building revisited," Biology & Philosophy, 15 (2): 197-210.

"How does the commons become tragic? Simple models as complex socio-political constructions," Science as Culture, 7 (4), 449-464, 1998.

"Natural Selection: A heavy hand in biological and social thought," Science as Culture, 7 (1), 5-32, 1998. Reprinted as "La selección natural: Un lastre sobre el pensamiento biológico y social," Ludus Vitalis, 7 (12), 27-51, 2000.

"Building on construction: An exploration of heterogeneous constructionism, using an analogy from psychology and a sketch from socio-economic modelling" Perspectives on Science, 3(1), 66-98, 1995.

"The social analysis of ecological change: From systems to intersecting processes" Social Science Information, 34: 5-30, 1995. (With R. García-Barrios) Also published, slightly modified, as "El analisis social del cambio ecológico, El medio ambiente: Una perspectiva económica social" pp. 67-93 in J. Jardon (ed.). Recursos, Energia y Cambio Social. Mexico: Plaza y Valdez Editores, 1995.

"How do we know we have global environmental problems?: Science and the globalization of environmental discourse" Geoforum, 23: 405-416, 1992. (With F. Buttel)

"Environmental sociology and global environmental change: A critical assessment" Society and Natural Resources, 5:211-230, 1992 (With F. Buttel*) Revised version, pp. 228-255 in M. Redclift & T. Benton (eds.) Social Theory and the Global Environment, Routledge, 1994.

"Ecosystems as circuits: Diagrams and the limits of physical analogies" Biology & Philosophy, 6:275-294, 1991. (With A. Blum)

"Revising models and generating theory" Oikos 54:121-126, 1989.

"Technocratic optimism, H.T. Odum and the partial transformation of ecological metaphor after World War 2" J. Hist. Biol. 21:213-244, 1988.

"The construction and turnover of complex community models having Generalized Lotka-Volterra dynamics" J. Theor. Biol. 135:569-588, 1988.

"Consistent Scaling and Parameter Choice for Linear and Generalized Lotka-Volterra Models Used in Community Ecology" J. Theor. Biol. 135:543-568, 1988.

"Historical versus Selectionist Explanations in Evolutionary Theory" Cladistics 3: 1-13,1987.

Book chapters

"Reconstructing unruly ecological complexity: Science, interpretation, and critical, reflective practice," inA Discourse on the Sciences: Revisited, ed. B. de Sousa Santos, forthcoming.

"Gene-environment complexities: What is interesting to measure and to model?" in The Evolution of Population Biology: Modern Synthesis, ed. R. Singh, S. Jain, M. Uyenoyama, Cambridge: Cambridge University Press, forthcoming.

"'Whose trees are these?' Bridging the divide between subjects and outsider-researchers," for R. Eglash and G. DiChiro (eds.), Appropriating Technology: Vernacular Science and Social Power. Minneapolis: University of Minnesota Press, forthcoming.

"Non-standard lessons from the 'tragedy of the commons'," pp. 87-105 in M. Maniates (ed.) Encountering Global Environmental Politics: Teaching, Learning, and Empowering Knowledge. Boulder, CO: Rowman & Littlefield, 2003.

"Distributed agency within intersecting ecological, social, and scientific processes," pp. 313-332 in S. Oyama, P. Griffiths and R. Gray (Eds.), Cycles of Contingency: Developmental Systems and Evolution. Cambridge, MA: MIT Press, 2001.

"Philosophy of Ecology" in Encyclopedia of Life Sciences. London: Macmillan, 2001. (with Y. Haila)

"From natural selection to natural construction to disciplining unruly complexity: The challenge of integrating ecology into evolutionary theory," in R. Singh, K. Krimbas, D. Paul & J. Beatty (eds.), Thinking About Evolution: Historical, Philosophical and Political Perspectives, Cambridge: Cambridge University Press, 377-393, 2000.

"What can agents do?: Engaging with complexities of the post-Hardin commons" pp. 125-156 in L. Freese (ed.), Advances in Human Ecology, Vol. 8. Greenwich, CT: JAI Press, 1999.

"Mapping complex social-natural processes: Cases from Mexico and Africa," in F. Fischer and M. Hajer (eds.) Living with Nature: Environmental Discourse as Cultural Critique, Oxford: Oxford University Press, 121-134, 1999.

"Changing life in the New World Dis/Order," Introduction for Changing Life (with P.Edwards# & S. Halfon), 1-13, 1997.

"Shifting positions for knowing and intervening in the cultural politics of the life sciences," Afterword for Changing Life, 203-224, 1997.

"How do we know we have global environmental problems? Undifferentiated science-politics and its potential reconstruction," in Changing Life, 149-174, 1997.

"The dynamics of socio-environmental change and the limits of neo-Malthusian environmentalism," pp. 139-167 in M. Dore and T. Mount (eds.), Global Environmental Economics: Equity and the Limits to Markets. Oxford, Blackwell, 1999. (With R. García-Barrios#) Also published in revised form as "Dynamics and rhetorics of socio-environmental change: Critical perspectives on the limits of neo-Malthusian environmentalism," pp. 257-292 in L. Freese (ed.), Advances in Human Ecology, Vol. 6. Greenwich, CT: JAI Press, 1997.

"Re/constructing socio-ecologies: System dynamics modeling of nomadic pastoralists in sub-Saharan Africa" pp.115-148 in A. Clarke & J. Fujimura (eds.) The Right Tools for the Job: At Work in Twentieth Century Life Sciences, Princeton University Press, 1992.

"Community" pp. 52-60 in E.F. Keller & E. Lloyd (eds.) Keywords in Evolutionary Biology, Harvard University Press, 1992

Edited special editions of journals

"Philosophy of Ecology," Biology & Philosophy, 15 (2):155-238 (with Y. Haila#).

"Natural Contradictions: Links between Ecological science and Environmental politics," Science as Culture, 7 (4), 1998 (with Y. Haila#).

"Ecological visionaries and the politics of conservation," Environment and History, 3, 1997 (with R. Rajan#)

"Science studies," section of Social Text, 42, 1994-95.

"Pictorial representation in biology" Biology & Philosophy, 6, 1991 (with A. Blum).

Reviews, commentaries, and notes

"Critical Reflections on the Use of Remote Sensing and GIS Technologies in Human Ecological Research," Human Ecology, 2003 (with M. Turner*)

"Assessing biodiversity and ecological stability," Science, 290: 51, 2000.

"Teaching 'critical and creative thinking' about science-in-society at the University of Massachusetts," Bulletin of Science, Technology & Society, 19 (5): 424-425.

"Natural Contradictions: Links between Ecological Science and Environmental Politics," Science as Culture, 7 (4), 445-448, 1998. (with Y. Haila)

"Biology and the agents without history," Newsletter of the International Society for History, Philosophy, and Social Studies of Biology, Fall 1997.

"The politics of the conservation of nature," Environment and History, 3: 239-243, 1997.

"Making connections and respecting differences: Reconciling schemas for learning and group process," Connexions (Newsletter of the International Society for Exploring Teaching Alternatives), March & July 1997.

"Review of Social Theory and the Environment by David Goldblatt," Urban Studies, 34 (9), 1525-1527, 1997.

"Appearances notwithstanding, we are all doing something like political ecology" Social Epistemology, 11 (1): 111-127, 1997.

"What's in it for us (in science studies)? Notes on `The economics of science,' by Arthur Diamond," Knowledge and Policy, 9 (2/3): 55-57, 1996.

"Review of Science and Technology in a Multicultural World by David Hess," Science, Technology, and Human Values, 21(3): 358-362, 1996.

"Co-construction and process: a response to Sismondo's classification of constructivisms," Social Studies of Science, 25 (2): 348-359, 1995.

"Review of A History of the Ecosystem Concept in Ecology by Frank Golley" Isis, 86 (3): 523-524, 1995.

"Review of Foundations of Ecology L. Real & J. Brown (eds.) and Pioneer Ecologist by R. Croker" Isis, 84: 177-179, 1993.

"Pictorial representation in biology" Biology & Philosophy, 6:125-134, 1991. (With A. Blum)

"Feminist Tales: Review of The Total Devotion Machine and Other Stories by R. Love and The Recurring Silent Spring by P. Hynes," Science, Technology, and Human Values, 16 (4): 540-543, 1991.

"Unfilled Holes in Conceptual Niche Space?" Book Review of Cherrett, J.M. (ed.). Ecological concepts: the contribution of ecology to an understanding of the natural world, Ecology 72(2), pp. 759-760, 1991

"Developmental versus morphological approaches to modeling ecological complexity" Oikos 55:434-436, 1989

"Mapping workshops for teaching ecologyecology" Bulletin of the Ecological Society of America 70:123-125, 1989. (With Y. Haila)

"Glasnost?: Eyes Opening in the USSR" Science as Culture 3:124-132, 1988

"Dialectical Biology as Political Practice. An essay review of R. Levins & R. Lewontin The Dialectical Biologist" Radical Science 20: 81-111, 1986 (=L. Levidow (eds.) Science as Politics, Free Association Books)

Conference Proceedings

"Alternating between teacher and facilitator," Proceedings of the International Association of Facilitators 2000, http://www.iaf-world.org/iaf2000/Taylor.PDF

"Shifting frames: From divided to distributed psychologies of scientific agents," Proceedings of the Philosophy of Science Association 1994, Vol.2, 304-310

"Mapping ecologists' ecologies of knowledge" Proceedings of the Philosophy of Science Association 1990, Vol.2, 95-109

"The Strategy of Model Building in Ecology, Revisited" 8th. Int. Congr. Logic, Meth. & Phil. of Sci., Volume 2:308-311, 1987.

"Some computer programs for the analysis of genotype x environment interaction" Proc Int. Congr. Soc. Advances of Breeding Res. in Asia & Oceania, 3d(v.1):56-58, 1977. (With R. Eisemann, I.DeLacy and D.Byth).

"A new approach to the analysis of genotypic adaptation and genotype x environment interactions" and "A comparison of methods of analysis of GxE interactions and adaptation responses in a large data set" Proc Int. Congr. Soc. Advances of Breeding Res. in Asia & Oceania, 3d(v.1):16-22 and 41-46, 1977. (With R. Eisemann, I.DeLacy and D.Byth*).

Technical Reports

The Ecology of Bishop Creek Brown Trout; Vol. II: Trout Population Model & Vol. III:Trout Population Model User's Manual. Reports by BioSystems Analysis, Inc. to So. California Edison, 1991. (With A. Small)

"A description with some applications of MSNUCY, a computer model combining interspecific interactions with nutrient cycling" Envir. Sci. Division Publication 2419, O.R.N.L., 1985. (With W.M.Post.)

"Economic aspects of the use of water resources in the Kerang Region" Technical Paper no. 11 of the Institute of Applied Economic and Social Research (I.A.E.S.R.). (Second report to the Ministry of Water Resources, Victoria), 1979. (With J.Ferguson and A.Smith).

"The Kerang Farm Model" Technical Paper no. 12 of I.A.E.S.R, 1979.

"Economic aspects of the use of water resources in the Kerang Region" First report to the Ministry of Water Resources, Victoria, 1978. (With J. Ferguson and A. Smith).

WORKS IN PROGRESS

(See also links on website to Thought pieces and unpublished contributions)

The Limits of Ecology and the Re/construction of Unruly Complexity Book manuscript under review at the University of Chicago Press.

"Genes, gestation, and life experience: Complexities of environment and development in the age of DNA," submitted to Science as Culture.

"We know more than we are, at first, prepared to acknowledge: Journeying to develop critical thinking," submitted to Journal of Pedagogy, Pluralism, and Practice

"Generating environmental knowledge and inquiry through workshop processes"

"Exploring heuristics about social agency through interpretation of diagrams of nature and society," for How Does Nature Speak: Dynamic Understandings, ed. Y. Haila and C. Dyke

"The hidden complexity of simple models, or Why theorists of all kinds should be troubled by unmodeled variables having dynamical lives of their own,²for Complexities Of Life: Ecology, Society And Health, ef. T. Awerbach

"Notes towards guidelines about specific situations and specific ways in which specific technologies are of significant pedagogical benefit, " submitted to Connexions.

SELECTED PRESENTATIONS (1998-)

"Flexible engagement and open questions," Society for Social Studies of Science, November 2002.

"Genes, gestation, and life experiences: Environmental complexities in the Age of DNA," International Society for History, Philosophy, and Social Studies of Biology, July 1999; University of California, San Francisco, April 2002; Society for Social Studies of Science, November 2001.

"Unruly Ecological Complexities, Diagrams and Reflective Practitioners," Interdisciplinary Seminar in the Humanities and Fine Arts, University of Massachusetts, Amherst, November 2002.

"How do we know there is a population-environment problem?" Science-in-society, society-in-science workshop, University of Massachusetts, Boston, July 1999; Commonwealth Honors College, University of Massachusetts, Amherst, November 2002.

"Assisting others in ecological reconceptualization," Workshop on Handbook of Ecological Concepts, Maison des Sciences de l'Homme, Paris, October 2002.

"Reconstructing unruly ecological complexities: From knowing to practising to engaging," Center for Environmental Research, Leipzig, October 2002.

"Opening up the social dimensions of biocomplexity through case studies and ill-defined problems," BioQuest workshop on Teaching College Biology, Beloit College, June 2002.

"New Directions in Fostering Critical Thinking," Workshop for the Center for Improvement of Teaching, University of Massachusetts, Boston, April 2002.

"Yes, computers could do that, but why would you want them to? (Towards guidelines about specific situations and specific ways in which specific technologies are of significant pedagogical benefit)," Teaching with Media Workshop, Instructional Technology Center, University of Massachusetts, Boston, April 2002.

"Teaching with evolving tools: A lot about learning, a little about technology," panel member, "Teaching for Transformation" conference, University of Massachusetts, Boston, January 2002.

"Building transversal bridges between the social and the natural sciences," keynote speaker and workshop leader at the University of Coimbra symposium on "Research and the University," Portugal, January 2002.

"Generating environmental knowledge and inquiry through workshop processes," Session on "Innovative Educational Technology" at the Society for Social Studies of Science, November 2001.

"The limits of ecology and the re/construction of unruly complexity," Center for the Philosophy of Science, University of Minnesota, October 2001.

"No units anywhere, anytime? Multiple causality, intersecting processes, and ecology as a historical science," International Society for History, Philosophy, and Social Studies of Biology, July 2001.

"Fostering Critical Thinking, especially about Biology-in-Society," Workshop on Teaching History, Philosophy, and Social

Studies of Biology, July 2001.

"Building a Professional development Learning Community," and "Developing Unit Plans for Inquiry- and Problem-based Learning," Workshops for Eisenhower Professional Development Program in the South River/South Coastal Watershed, November 2001 and May 2001.

"Intersecting Processes and Reflexive Practitioners," Commentary on Session "Critical Perspectives on the use of GIS/Remore Sensing Techniques in People-and-Environment Research," Association of American Geographers, February 2001.

"Who is implicated and where are they engaged? Re/constructing social agency in the diagramming of social-natural processes," Conference on "Taking Nature Seriously," University of Oregon, February 2001 and University of Tampere, May 2001 (with C. London).

"Fostering critical thinking through attention to the inter- and intrapersonal," Center for Excellence in Teaching and Writing, Oregon State University, February 2001.

"Process and product in the generation of environmental knowledge and inquiry: A comparison of four innovative workshops," Department of Environmental, Coastal, and Oceanic Science, University of Massachusetts, Boston, November 2000.

"Generative Tensions in Science," Thinktank for Community-college teachers of critical thinking, University of Massachusetts, Boston, November 2000.

"Critical Incidents in Teaching," Workshops for the Center for Improvement of Teaching, University of Massachusetts, Boston, April and October 2000.

"How the commons becomes 'tragic': Teaching about the hidden complexity of simple models to students and environmental researchers," University of Sydney, July 2000.

"The hidden complexity of simple models, or Why theorists of all kinds should be troubled by unmodeled variables having dynamical lives of their own," Symposium in Honor of Richard Levins, Harvard University, June 2000.

"Knowledge-making, social agency, and complexity in environmental analysis," University of Tampere, Finland, May 2000.

"Alternating between teacher and facilitator," International Association of Facilitators, Toronto, April 2000.

"What can agents do?: Engaging with complexities of the post-Hardin commons," Harvard University, March 1999, University of California, Santa Cruz, May 1999, Yale University, October 1999, University of California, Berkeley, February 2000.

"Making the Implicit Explicit: Working to Understand and Expand Students' Conceptions of Academic Work," Panel presentation/workshop, Conference on Teaching and Transformation, University of Massachusetts, Boston, January 2000.

"How do we know there is a population-environment problem?" Science-in-society, society-in-science workshop, University of Massachusetts, Boston, July 1999.

"The challenges of integrating ecology into evolutionary theory," BioQuest workshop on Teaching College Biology, Beloit College, June 1999.

"Critical Thinking," Honors Faculty Development Workshop for Massachusetts Board of Higher Education, June 1999.

"How can one address complexity to facilitate 'reorganizing'?," Centro Regional de Investigaciones Multidisciplinarias, U.N.A.M., México, November 1998.

"What can agents do?: Reflections on post-Hardin commons discourse," Workshop on "Old and new directions in 'Commons' research," Rutgers University, February 1997, Society for Social Studies of Science, October 1988.

"How can we make complexity facilitate social change?," International Society for Exploring Teaching Alternatives, October 1998.

"How do we know we have global environmental problems? Critical thinking about environment, science, and society," University of Massachusetts, Boston, April 1998.

"Reframing environmental analysis so as to multiply the possible sites of social mobilization: The population-environment relation reexamined," Antioch College, March 1998.

"How do we know we have global environmental problems? (And how can we make complexity facilitate social change?)," Swarthmore College, February 1998.

1/03

PUBLICATIONS since 1998 and selected prior publications

For full list of publications see curriculum vitae

Publications marked * form the basis of the chapters indicated from The Limits of Ecology (under contract with the University of Chicago Press and submitted for review mid-July), so readers can choose whether to read the original publications or the book manuscript.

Refereed Articles

"Situatedness and Problematic Boundaries: Conceptualizing Life's Complex Ecological Context," **Biology & Philosophy**, in press

"Socio-ecological webs and sites of sociality: Levins' strategy of model building revisited," **Biology & Philosophy**, 15 (2), 197-210, 2000.* *(LoE, chap. 2)*

"How does the commons become tragic? Simple models as complex socio-political constructions" **Science as Culture**, 7 (4), 449-464, 1998.

"Natural Selection: A heavy hand in biological and social thought," **Science as Culture**, 7 (1), 5-32, 1998.

"Building on construction: An exploration of heterogeneous constructionism, using an analogy from psychology and a sketch from socio-economic modelling" **Perspectives on Science**, 3(1), 66-98, 1995.* *(the second half has been worked into LoE, chap. 4A)*

"The social analysis of ecological change: From systems to intersecting processes" **Social Science Information**, 34: 5-30, 1995. (With R. García-Barrios)

"Ecosystems as circuits: Diagrams and the limits of physical analogies" **Biology & Philosophy**, 6:275-294, 1991. (With A. Blum)* *(LoE, chap. 3B)*

"Technocratic optimism, H.T. Odum and the partial transformation of ecological metaphor after World War 2" **J. Hist. Biol.** 21:213-244, 1988.* *(LoE, chap. 3A)*

Book chapters

"Philosophy of Ecology," Encyclopedia of Life Sciences. London: Macmillan, 2001. (with Y. Haila)

"'Whose trees are these?' Bridging the divide between subjects and outsider-researchers," for R. Eglash and G. DiChiro (eds.), Appropriating Technology. Minneapolis: University of Minnesota Press, forthcoming.* *(LoE, Interlude)*

"Distributed agency within intersecting ecological, social, and scientific processes," pp. 313-332 in S. Oyama, P. Griffiths and R. Gray (Eds.), Cycles of Contingency: Developmental Systems and Evolution. Cambridge, MA: MIT Press, 2000.

"Non-standard lessons from the 'tragedy of the commons'," in M. Maniates (ed.) Empowering

Knowledge: A Primer for Teaching and Learning Global Environmental Politics. Rowman & Littlefield, forthcoming.

"What can agents do?: Engaging with complexities of the post-Hardin commons," pp. 125-156 in L. Freese (ed.), Advances in Human Ecology, Vol. 8. Greenwich, CT: JAI Press, 1999.* *(LoE, chap. 6)*

"Mapping complex social-natural processes: Cases from Mexico and Africa," in F. Fischer and M. Hajer (eds.) Living with Nature: Environmental Discourse as Cultural Critique, Oxford: Oxford University Press, 121-134, 1999.

"From natural selection to natural construction to disciplining unruly complexity: The challenge of integrating ecology into evolutionary theory," in R. Singh, K. Krimbas, D. Paul & J. Beatty (eds.), Thinking About Evolution: Historical, Philosophical and Political Perspectives, Cambridge: Cambridge University Press, 377-393, 2000.

"How do we know we have global environmental problems? Undifferentiated science-politics and its potential reconstruction," in P. Taylor, S. Halfon & P. Edwards (eds.) Changing Life: Genomes, Ecologies, Bodies, Commodities Minneapolis: University of Minnesota Press, 149-174, 1997.

"The dynamics of socio-environmental change and the limits of neo-Malthusian environmentalism," in M. Dore and T. Mount (eds.), Global Environmental Economics: Equity and the Limits to Markets. Oxford, Blackwell, 139-167, 1999. (With R. García-Barrios)

"Re/constructing socio-ecologies: System dynamics modeling of nomadic pastoralists in sub-Saharan Africa" pp.115-148 in A. Clarke & J. Fujimura (eds.) The Right Tools for the Job: At Work in Twentieth Century Life Sciences, Princeton University Press, 1992.* *(LoE, chap. 4B and 5A)*

"Community" pp. 52-60 in E.F. Keller & E. Lloyd (eds.) Keywords in Evolutionary Biology, Harvard University Press, 1992

Reviews, commentaries, and notes

"Making connections and respecting differences: Reconciling schemas for learning and group process," **Connexions** (Newsletter of the International Society for Exploring Teaching Alternatives), March & July 1997.

"Appearances notwithstanding, we are all doing something like political ecology" **Social Epistemology**, 11 (1): 111-127, 1997.

Conference Proceedings

"Alternating between teacher and facilitator," **Proceedings of the International Association of Facilitators 2000**, http://www.iaf-world.org, 2000

"Mapping ecologists' ecologies of knowledge" **Proceedings of the Philosophy of Science**

Association 1990, Vol.2, 95-109* *(LoE, chap. 5B)*

Works In Progress

** items not sent to outside reviewers

The Limits of Ecology and the Re/construction of Unruly Complexity Book manuscript for the University of Chicago Press.

"Genes, gestation, and life experience: Environmental complexities in the age of DNA," for Science as Culture**

"Exploring heuristics about social agency through interpretation of diagrams of nature and society," for How Does Nature Speak: Dynamic Understandings, ed. Y. Haila and C. Dyke**

"The hidden complexity of simple models, or Why theorists of all kinds should be troubled by unmodeled variables having dynamical lives of their own," for Complexities Of Life: Ecology, Society And Health, ef. T. Awerbach* *(LoE, chap. 1B)*

"Critical thinking re-seen: Journeying and opening up questions"**

ABSTRACTS & INTRODUCTIONS

Peter Taylor

What follows are the abstracts or the introductions for many publications (by publication date, with most recent first) and then selected unpublished presentations and works in progress (again by date of presentation).
These can be viewed by following scrolling down or by selecting the item in the c.v.
* indicates primary author other than PJT; # indicates equal joint authorship / editorship.
Last Update 11/02

"Reconstructing unruly ecological complexity: Science, interpretation, and critical, reflective practice," for A Discourse on the Sciences: Revisited, ed. B. de Sousa Santos, forthcoming.
Involvement in environmental issues in the 1970s led me, as it did many fellow activists, to study the science of ecology. Having a mathematical disposition, I chose to focus less on field studies and more on quantitative analysis and theoretical modeling. I soon developed an interest, which continues to this day, in the challenge that ecological complexity poses to conventional scientific ways of knowing. As I explored this challenge, my work in ecology and socio-environmental studies opened out to interpretive studies of science and then to facilitation of critical, reflective practice. Within each of these realms as well as in moving among them, my interest became to problematize the conceptual boundaries that researchers use to partition of complex situations into well-bounded systems and backgrounded or hidden processes.
When researchers assume that there are systems with clearly defined boundaries, coherent internal dynamics, and simply mediated relations with their external context, they can locate themselves outside the systems and seek generalizations and principles affording a natural or economical reduction of complexity. A contrasting image is that well-bounded systems, when they are encountered, require explanation as special cases of unruly complexity, in which boundaries and categories are problematic, levels and scales are not clearly separable, structures are subject to restructuring, and components undergo ongoing differentiation in relation to each other. Control and generalization are difficult and no privileged standpoint exists. The position I have come to is that researchers who want to discipline unruly complexity, but not to suppress it, have to pay more attention to their own agency within the participatory restructuring of knowledge making and social change.
This essay reconstructs my intellectual journey towards this position, one that resonates with de Sousa Santos's (1992) Discourse on the Sciences. The episodes are less about participatory restructuring, however, than they are about exploring concepts and eventually coming to articulate my project in terms of intersections among three strands: disciplining unruly complexity; linking knowledge making to changing diverse social relations; and wrestling with the potential and limitations of conceptual exploration. With respect to this last strand, the detail I present will be specific to my own inquiries, but the themes developed are meant to stimulate readers to problematize analogous boundaries and address analogous complexities in their own fields of inquiry and practice. I believe that the concepts and issues I raise should be taken up more broadly, but I have no hesitation admitting the heuristic intent of the essay. I recognize that analogies can be applied in circumstances for which they do not serve well or can misguide the theorist. As will become evident, however, I am especially interested in

conceptual moves that open up issues about addressing complexity, but do so in ways that point to further work that needs to be undertaken to deal with particular cases.

"Critical Reflections on the Use of Remote Sensing and GIS Technologies in Human Ecological Research," **Human Ecology**, 2003 (with M. Turner*)

"Non-standard lessons from the 'tragedy of the commons'," pp. 87-105 in M. Maniates (ed.) Encountering Global Environmental Politics: Teaching, Learning, and Empowering Knowledge. Boulder, CO: Rowman & Littlefield, 2003.

Though widely critiqued for its assumption that groups of individuals are incapable of self-organizing, Garrett Hardin's idea of the "tragedy of the commons" remains a very influential framework for environmental policymakers and activists alike. Introductory textbooks frequently present the tragedy as fact of life, while intermediate treatments of policymaking adopt threats to the commons as an organizing structure. The framework is both pervasive and insidious. Its simplicity is alluring, but its underlying claims about the limits of human stewardship of nature and capacity for ?thinking outside the box,?if accepted acritically, make it almost impossible to fathom how we might together devise systems of global environmental governance.

Peter Taylor... is an environmental and science educator who likes to illuminate established ideas from new angles. He helps his students understand hidden assumptions, especially where they concern people's "agency" -- their ability to influence the practice of environmental research and politics. In this essay he begins with a report on his classroom simulation of the tragedy. His observations of students' responses to the simulation allow him to highlight the shortcomings of the idea and also to comment on the ways that people use simple models to address ecological and social complexity. In a second section he describes extensions appropriate for more advanced undergraduate and graduate classes. In the final section he spells out his vision of critical thinking and the productive role for ambiguity. You are welcome to read this section early on if you would like to know more in advance about where he is taking you. However, if you just let the ideas emerge as the chapter unfolds, your experience will more closely approximate the one Taylor intends for his students. (PDF full text version)

"'Whose trees are these?' Bridging the divide between subjects and outsider-researchers," for R. Eglash and G. DiChiro (eds.), Appropriating Technology. Minneapolis: University of Minnesota Press, forthcoming.

The ideal of Participatory Action Research (PAR) (Greenwood and Levin 1998) is that researchers shape their inquiries through on-going work with and empowerment of people whose lives stand to be most affected by some change in social policy or technological development, such digging of deep wells for irrigation. In the first half of this essay, I describe a Kenyan agro-forestry project that exemplifies PAR and shows its potential for bridging the divide between subjects and outsider-researchers. The professional agroforesters in the project facilitated the appropriation by farmers and other community members of the "technology" of doing research and the result was science and technology more appropriate for the farms and community than if the agroforesters had produced it for them.

The example of PAR in agro-forestry inspires the second half of this short essay, in which I sketch an equivalent appropriation of the doing of research in another field‹social studies of science and technology (STS). Certain prominent figures in STS have drawn attention to the complexity of agents and resources involved in shaping science and technology (Law 1986, Latour 1987, Haraway 1994). Although this emphasis has been conceptually and rhetorically

influential, it has not led to a systematic framework for exposing possible points of engagement for STS researchers and other agents. However, STS researchers who embrace the ideal of PAR and insist on bridging the divide between subjects and outsider-researchers are well positioned to appropriate STS's conceptual center and produce a more powerful framework for addressing the "unruliness" of "constructed" complexity.

Situatedness and Problematic Boundaries: Conceptualizing Life's Complex Ecological Context," **Biology & Philosophy**, 16 (4), 521-532, 2001. (with Y. Haila).

A key challenge in conceptualizing ecological complexity is to allow simultaneously for particularity, contingency, and structure, and for such structure to change, be internally differentiated, and have problematic boundaries. Together with the fact that all organisms live in dynamic ecological contexts, this gives philosophy of ecology the potential to be a site where difficult questions are addressed concerning the situatedness or positionality of organisms‹humans included‹in their intersecting worlds. (PDF full text version)

"Distributed agency within intersecting ecological, social, and scientific processes," pp. 313-332 in S. Oyama, P. Griffiths and R. Gray (Eds.), Cycles of Contingency: Developmental Systems and Evolution. Cambridge, MA: MIT Press, 2001

Whenever theory has built on the dynamic unity and coherency of structures or units, we might consider, instead, what would follow if those units were to be explained as contingent outcomes of "intersecting processes." This broad heuristic informs this essay's extensions of Developmental Systems Theory to cases in the sociology of mental illness, social-environmental studies, and social studies of science. I link the three cases in a project of reconceptualizing human agents, in particular agents who are establishing knowledge and engaging in change. I show that viewing agents in terms of intersecting processes is also equivalent to teasing open their "heterogeneous construction," that is, their contingent and on-going mobilizing of webs of diverse materials, tools, people, and other resources.

"From natural selection to natural construction to disciplining unruly complexity: The challenge of integrating ecology into evolutionary theory," in R. Singh, K. Krimbas, D. Paul & J. Beatty (eds.), Thinking About Evolution: Historical, Philosophical and Political Perspectives, Cambridge: Cambridge University Press, 377-393, 2000.

In the third chapter of On the Origin of Species, Darwin introduced his concept of natural selection by noting that, given the struggle for existence, "any variation, however slight and from whatever cause proceeeding, if it is in any degree profitable to an individual of any species in its infinitely complex relations to other organic beings and to external nature, will tend to the preservation of that individual, and will generally be inherited by its offspring" (Darwin 1859, p.61, my emphasis). That is, all evolution occurs in an ecological context. The structure and dynamics of evolution's ecological context have not, however, been well integrated into evolutionary theory. Population genetic evolutionary theory, most notably, has avoided unravelling ecological complexity by compressing organism-organism and organism-environment relationships into the fitness conferred on an organism by its characters. The center stage in theory could then be occupied by the genetic basis and differential representation of characters within single species. In turn, speciation could become a process of genetic divergence, in which the environment mostly took the role of raising and lowering

barriers to gene flow.
In this essay I bring into focus the challenges of making evolutionary theory more ecological. Or, given that ecological dynamics are implicit in any evolutionary theory, I might say, making these dynamics explicit. Writing in the spirit of Lewontin's essays on organisms constructing their environments, I do not present a well formed program of ecological evolutionary theory, but point to the existence of problems. My aim is to provoke further, much needed, discussion.

There are two strands to my argument, which correspond to two interpretations of the quote from Darwin above. Read one way, Darwin was deflecting attention from a major weakness in the conceptual structure of natural selection as a theory of evolutionary change. "Do not ask me," Darwin is saying, "to identify which characters of an organism confer fitness; there are too many indirect interactions and feedbacks to do this reliably. Just take it as self-evident that there must be such characteristics." Suppose instead that we focus attention on identifying such characters, the critera by which nature "selects." In part I I examine the resulting problems and argue that they warrant replacing the metaphor of natural selection; "natural construction" is my proposal. Of these problems, the one that concerns me most here is the non-integration of ecological dynamics into evolutionary theory.

A second, more charitable and forward looking, reading of the passage quoted is that Darwin foreshadowed an integrated ecological-evolutionary theory. In this spirit, part II of this essay reviews approaches to theorizing ecological organization, with the goal of identifying a) ways evolutionary theory fits into them (explicitly and implicitly); and b) more precisely the shape of the challenge of integrating ecological dynamics into evolutionary theory. I conclude that to meet the challenge of integrating ecology into evolutionary theory, natural constructionists would need to be recognize that ecological complexity is more "unruly" than it is structured or "system-like."

"Philosophy of Ecology" in Encyclopedia of Life Sciences. London: Macmillan, 2001. (with Y. Haila)

"The Philosophical dullness of classical ecology, and a Levinsian alternative," **Biology & Philosophy**, 16 (1), 93-102, 2001. (with Y. Haila*)

"Socio-ecological webs and sites of sociality : Levins' strategy of model building revisited," **Biology & Philosophy**, 15 (2): 197-210.

This essay reformulates Levins' analysis of model building in ecology and evolutionary biology so as to identify several points where decisions are required that are not determined by nature for example, the range of competing models compared. These decisions are an unavoidable part of modeling, which invites us to examine what else modelers are responding to, what reactions are taking place at these "sites of sociality." It seems that scientists "select their problems, define their categories, collect their data, and present their findings so that, simultaneously, the models can be seen to represent their subject matter, the modelers can secure the support of colleagues, collaborators and institutions, and they can enjoin others to act upon their conclusions;" scientists are weavers of "socio-ecological webs."

"What can agents do?: Engaging with complexities of the post-Hardin commons" pp. 125-156 in L. Freese (ed.), Advances in Human Ecology, Vol. 8. Greenwich, CT: JAI Press, 1999.

Since the mid 1980s the institutions through which non-privatized, common resources are managed have been examined by a growing number of social-environmental researchers. Actual agents, it emerges, often do better than those envisaged in Garrett Hardin's influential 1968 paper on the "tragedy of the commons." Where commons research revolves around the question "What can agents do?," my interest in the complexities of both environmental and scientific change leads me to ask a complementary question, "What social change can researchers affect or facilitate with their various understandings?" The relevant understandings concern not only the situations that commons researchers study, but also the social situations in which the researchers are embedded. I contrast simple formulations of well-bounded systems with work that attends to "intersecting processes" or dynamics among particular, unequal agents whose actions implicate or span a range of social realms. "Critical heuristics" are introduced as a means to address tensions among these two poles. The resulting multi-part framework is intended to apply to environmental and scientific analyses and to analyses from social studies of science and technology. The ultimate goal of this essay is to stimulate further work on what agents can do‹but not alone or through their accounts of the world alone‹to contribute self-consciously to the on-going restructuring of the intersecting processes in which particular knowledge-making and social changing agents are situated.

How does the commons become tragic? Simple models as complex socio-political constructions," **Science as Culture** 7 (4), 449-464, 1998.

All ecological theorizing and all circumstances studied in ecology can be viewed as "situated." Diverse intersecting strands shape the social situations in which research can be undertake, and a similar complexity of intersecting processes constitute the objects and situations it studies. To illustrate and support this perspective, this essay reinterprets a simple, but very influential model of environmental degradation, Garrett Hardin's "tragedy of the commons." I want to make plausible the idea that when any phenomenon is analyzed as a coherent system -- and this is what Hardin's model does -- this analysis can be reinterpreted in terms of the specialness of the circumstances selected to be studied and in terms of other "rhetorical" work done in making the phenomenon appear system-like. The conventional strategies in science gives priority -- in method, theoretical development, and aesthetics -- to posing simple principles behind complex appearances. A lot of new thinking can be opened up by inversion of this relationship, by recognizing that simple models should be read as entailing complex social constructions.

"Natural Selection: The heavy hand"

Social Darwinising-the reading of social meanings into and back out of biology-is facilitated by the basic conceptual structure or explanatory form of natural selection, one that seductively shortcuts the difficulties of explaining not only social but also biological phenomena. The conceptual scheme simply invites Darwinists to interpret what they see as something that is here because it triumphed through selection; they can accordingly flatten and squeeze history and function to fit. Moreover, the scheme entices Darwinists to promote what they would like

to see, e.g., consolidation in the banking industry, as coming about because it is favoured by a natural, inevitable and right process of selection. In these ways Darwinian explanations about our behaviours and societies weigh heavily upon our imagination of social possibilities. In building my argument I employ Darwin's classic, On the Origin of Species, which provides a clear and multi-layered framework for appreciating what Darwinism entails.

"The dynamics of socio-environmental change and the limits of neo-Malthusian environmentalism," in T. Mount, H. Shue and M. Dore (Eds.), The limits to markets: Equity and the global environment. Oxford, Blackwell. (With R. Garci'a-Barrios#)

Population size or growth and environmental degradation are not related in any direct way. Focussing on the poor in rural societies, we show that, in order to understand the degradation of their environments, one needs to analyse the dynamics linking changes in the labour supply, the social organisation of production, technology, and the environment. Implicated in the maintenance, breakdown, or reorganisation of local institutions of production are the differentiation in any society or community, its social psychology (of norms and reciprocal expectations), and larger economic structures. In contrast, what we call neo-Malthusian environmentalism points to aggregate regional, national or global statistics and to calculations of ultimate bio-physical limits. We argue that these give very little insight into the social/ economic/ environmental dynamics of socio-environmental change.
Noting the persistent appeal of both the science and the politics of neo-Malthusian environmentalism, we interpret them as underwritten by both moralistic and technocratic conceptions of social action. The logical consequences of this discourse are unintended and undesirable effects, which contribute, contrary to the intentions of most environmentalists, to coercion and violence in the name of the environment.

Changing life: Genomes, ecologies, bodies, commodities. University of Minnesota Press (ed. with S. Halfon & P. Edwards)

From the cover: "A fascinating look at how the culture of today's life sciences affects our culture.

In laboratories all over the world, life-even the idea of life-is changing. And with these changes, whether they result in square tomatoes or cyborgs, come transformations in our social order-sometimes welcome, sometimes troubling, depending on where we stand. Changing Life offers a close look at how the mutable forms and concepts of life link the processes of science to those of information, finance, and commodities.

The contributors, drawn from disciplines within science and technology studies and from geography, ecology, and developmental biology, provide a range of interpretive angles on the metaphors, narratives, models, and practices of the life sciences. Their essays-about planetary management and genome sequencing, ecologies and cyborgs-address actual and imagined transformations at the center and at the margins of transnational relations, during the post-Cold War era and in times to come. They consider such topics as the declining regulatory state, ascendant transnational networks, and capital's legal reign over intellectual property, life-form patents, and marketable pollution licenses.

Changing Life argues that we cannot understand the power of the life sciences in modern society without exploring the intersections of science and technology with other cultural realms. To that end, this book represents a collective attempt to join the insights of science and technology studies and cultural studies. As a work of cultural politics, it makes a contribution to changing life in a context of changing social order."

Contributors: Simon Cole, Cornell U; Paul Edwards, Stanford U.; Scott Gilbert, Swarthmore College; Herbert Gottweis, U of Salzburg; Yrjö Haila, U of Tampere, Finland; Saul Halfon, Cornell U.; Rosaleen Love, Victoria U of Technology, Melbourne, Australia; and Richard Schroeder, Rutgers.

"How do we know we have global environmental problems? Undifferentiated science-politics and its potential reconstruction" in Changing Life.

Science has a central role in shaping what count as environmental problems, evident especially in the success of planetary science and environmental activism in stimulating awareness and discussion of global environmental problems. I advance four propositions about the special relationship between environmental science and politics: 1) In the formulation of science, not just its application certain course of action are facilitated over others; 2) In global environmental discourse, moral and technocratic view of social action have been privileged; 3) Global environmental change, as a framework for science and political mobilization, is vulnerable to surprises from unintended outcomes, unpredicted conflicts, and unlikely coalitions. These stem from different nations and differentiated social groups within nations having different interests in causing and alleviating environmental problems; and 4) Despite this vulnerability, globalized discourse in many ways is facilitating for many planetary scientists and environmental activists; reconstruction of environmental discourse requires more than the reconceptualization of science and politics I introduce.
I develop these propositions through a reinterpretation of The Limits to Growth study of the early 1970s and extensions of this to current studies of climate change and its human/social impacts; examples illustrating the vulnerability of global formulations of environmental issues, and a review of some of the developments in the 1980s that facilitated this form of science and politics.
I finish by reflecting on my own counter-exemplification; the four broad brush propositions can be read as attempts, like the frameworks they critique, to cut through the unequal and heterogeneous practical and conceptual facilitations of science and political mobilization. Without eliminating this contradiction, I reformulate the propositions as useful heuristics or accusations with which one can work to expose more of that heterogeneity.

"What's in it for us (in science studies)? Notes on "The economics of science," by Arthur Diamond," Knowledge and Policy, 9 (2/3): 55-57, 1996.

Committed to the idea that scientists, like all individuals, are utility maximizers, Diamond has reviewed the literature on the reward structures of science and what they explain about the behavior of scientists. Before science studiers begin to act as if there is much for them in the economics of science, economists ought to follow the lead of science studies and subject claims

of knowledge and relevance to sophisticated philosophical, historical, cultural and political analyses. A fruitful two-way dialogue might then ensue.

"Building on construction: An exploration of heterogeneous constructionism, using an analogy from psychology and a sketch from socio-economic modelling" Perspectives on Science, 3(1), 66-98.

I explore heterogeneous constructionism, my term for the perspective that science in the making is a process of agents building by combining a diversity of components. Issues addressed include causality and explanation; transcending both realism and relativism; scientists as acting, intervening, and imaginative agents; explanations that span many levels of social practice; counterfactuals in the analysis of causal claims; and practical reflexivity. An analogy from research on the social origins of depression and a sketch from my own experience in socioeconomic modeling are used to motivate and render more concrete the form of heterogeneous constructionism I am advocating.

"Co-construction and process: a response to Sismondo's classification of constructivisms" Social Studies of Science, 25 (2): 348-359.

Any classification into types can clarify our view of the whole while, at the same time, distracting our attention from hybrids and the processes by which they are formed and sustained. In this light, the recent review by Sismondo, which teases out some of the multiple meanings given to the term 'construction,' and his subsequent exchange with Knorr Cetina, should leave us troubled. Many of us are interested in the processes of science in the making, in which scientific theories, materials, tools, language, institutions, and wider social relations are being co-constructed, and are trying to analyse the diverse 'resources' drawn upon by agents in such co-construction processes. Sismondo's classification makes little space for that strand of social studies of science, focussing as it does on the type of thing being produced, not the processes of their production. Knorr Cetina does not take issue with him on that account. She applauds his review as an overdue clarification of constructivisms (constructionisms) and, after a brief plug for philosophers to become more sociological, centres her response on defending a conceptual claim about representations preceeding existence. If clarification means providing distinctions we should work with, we should be less satisfied with Sismondo's taxonomy. I feel like a misfit, and so, I suspect, do the many who have over the last decade been attracted to ideas such as 'ecologies of knowledge,' 'intersecting social worlds,' 'heterogeneous engineering,' and actors' 'networks' of resources. This note, however, does not criticise Sismondo just for the omission of a major category of constructivism, but argues that, from the perspective of what is omitted, his classification scheme breaks down. The distinctions do not hold in practice and Sismondo's conclusions about reconciling social studies of science with philosophy and about politics are not justified.

"The social analysis of ecological change: From systems to intersecting processes" Social Science Information, 34: 5-30, 1995. (With R. Garci'a-Barrios) Also published, slightly modified, as "El analisis social del cambio ecolo'gico," in J. Jardon (ed.). Recursos, Energia y Cambio Social. Mexico: Universidad Nacional Autonoma de Mexico, 1995.

Scientific analyses of ecological and social-ecological relations can be read, not only as representations of reality having greater or lesser empirical adequacy, but also as rhetoric about social action desired by the scientists in their given contexts. The task we set ourselves in this essay is to examine different approaches to understanding social-ecological relations, drawing upon the related themes of the constructedness of nature(s) and the contextuality of science. What we see is that the different approaches can be located along one major axis. At one pole lie views and approaches that construct from ecology and from society natural units, "systems" in the strong sense of having clearly defined boundaries and coherent internal dynamics governing their development, structure and stability, and their adaptation to external influences. (Although system can be used more loosely to designate simply a collection of many interacting elements, we confine ourselves to strong view; in our view it is from this that most theory derives.) Observers can thus locate themselves outside the systems studied, and seek generalisations and principles affording a natural reduction of complexity. At the other pole, amplifying the epigraph from Wolf on the fluidity of societies, we find analysts grappling with historically contingent situations resulting from intersecting processes, in which boundaries and categories are problematic, levels and scales are not clearly separable, and structures are subject to restructuring. Differentiation and change, not adaptation or equilibrium, characterises these situations of "unruly complexity." Control and generalisation are difficult and no privileged standpoint exists; in fact, the boundary between scientist and engaged participant can hardly be maintained (Taylor 1990, 1992a). (We add more aspects to the systems-intersecting processes contrast as we proceed.)

We want to reinforce and stimulate interest in work that moves us towards the second pole, the "social analysis of ecological change," as we call it, and to highlight the more subtle science it provides. It is not at all easy to make sense of diverse intersecting processes without affording one side of persistent dichotomies, such as global-local, nature-society, individual-environment, and science-interpretation, a privileged position over, and abstracted from the other. But, to the extent that people take on this task, social analysis of ecological change promises to contribute significantly to the development of social theory more generally. Of course, no end-point or mature version yet exists for us to point to; instead people have been taking many directions, with greater and lesser self-consciousness of the theoretical challenges entailed, and in recurrent tension with system-like tendencies and the demands for objective accounts that still dominate science.

We tease out various dimensions of the tension between approaches based on systems and those unravelling intersecting processes, evident in divergent answers to questions such as: What do peasants and indigenous peoples know about their environment? What knowledge are they able to put into practice? How do we come to know these things about them? How is human rationality -- economic, ecological and otherwise -- rhetorically constructed?; likewise, human-environment adaptation, traditional societies and primitiveness? How do local social-environmental situations intersect with larger political economic processes? Can ecological and social dynamics and, similarly, material and cultural processes, be theoretically integrated? Our discussion of these issues provides a critique of systems approaches (dominant in the post war decades, but still popular today) and, at the same time, indicates the openness of the intellectual terrain facing theorists of intersecting processes. That is, notwithstanding the somewhat polemical paragraphs we allow ourselves at the end of this essay, there is no simple moral in the social analysis of ecological change, nor is there likely to be.

A few notes on the scope of what follows: Our orientation is towards Anglo-American studies of rural and Third world situations, and so our discussion spans fields such as anthropology, human ecology, range ecology, geography, environmental history, and social studies of science. The range of fields in a "social analysis of ecological change" should, however, be extended

sometime to cover urban and industrial environmental analyses; similarly, a comparison with non-Anglo-American studies would be valuable. Even within the scope just defined, the citations are intended to provide key entry-points only; our goal is not exhaustive coverage of the literature, but to motivate the interpretive themes or dimensions laid out above. With this agenda, the review follows more or less a historical sequence, which helps us to locate the origins of the different approaches, trace their development, and convey a sense of momentum or progress towards the intersecting processes view.

"Review of A History of the Ecosystem Concept in Ecology by Frank Golley" **Isis**, 86 (3): 523-524, 1995.

"Shifting frames: From divided to distributed psychologies of scientific agents," Proceedings of the Philosophy of Science Association 1994, Vol.2, 304-310.
I characterize and then complicate Solomon, Thagard and Goldman's framing of the issue of integrating cognitive and social factors in explaining science. I sketch a radically different framing which distributes the mind beyond the brain, embodies it, and has that mind-body-person become, as s/he always is, an agent acting in a society. I also find problems in Solomon's construal of multivariate statistics, Thagard's analogies for multivariate analysis, and Goldman's faith in the capacity of the community of users of scientific method to home in on true beliefs.

"Review of Foundations of Ecology L. Real & J. Brown (eds.) and Pioneer Ecologist by R. Croker" Isis, 84: 177-179, 1993.

"How do we know we have global environmental problems?: Science and the globalization of environmental discourse" Geoforum, 23: 405-416, 1992. (With F. Buttel) -- see revised version

---

"Environmental sociology and global environmental change: A critical assessment" Society and Natural Resources, 5:211-230, 1992 (With F. Buttel*) Revised version, pp. 228-255 in M. Redclift & T. Benton (eds.) Social Theory and the Global Environment, Routledge, 1994.

"Re/constructing socio-ecologies: System dynamics modeling of nomadic pastoralists in sub-Saharan Africa" pp.115-148 in A. Clarke & J. Fujimura (eds.) The Right Tools for the Job: At Work in Twentieth Century Life Sciences, Princeton University Press, 1992.

By 1973 the semi-arid Sahel region of West Africa had experienced five years of drought and developing crisis. Many pastoralists (livestock herders) and farmers were in refugee camps, their herds decimated and their crops having failed again. Western commentators at the time focussed not only on famine relief but on the causes of the crisis and on prospects for the regions' future. Some saw the Sahelian drought and famine as a forerunner of further widespread population-resource crises to come; almost all agreed that the ecological resource base of the Sahel region had been seriously damaged. Once emergency relief was underway, discussion turned to longer term measures needed for recovery and for prevention of future disasters. The U.S. Agency for International development (USAID) funded a one-year, $1 million project at Massachusetts Institute of Technology (MIT) to evaluate long-term development strategies for the Sahel and the bordering "Sudan" region. One component of the project was a study of nomadic pastoralists. These livestock herders spend part of each year moving with their livestock over the range in search of pasture, a migration necessary because

rainfall in the Sahel is patchy in distribution and varies greatly from year to year, dramatically affecting the location of good pasture. After a three week visit to the region a graduate student at MIT, whom I shall call "M", with a background in systems analyses of population and ecological issues, constructed and reported on a sequence of three system dynamic models "for understanding the ecological and social dynamics of the pastoral system." M's models of pastoralists included many factors and mathematical relationships. Yet he summarized his findings simply, in terms of the "tragedy of the commons" (Hardin 1968): Each herder with access to common rangeland follows the same logic: "I will receive the benefit in the short run from increasing my herd by one animal; everyone will share any cost of diminished pasture per animal; therefore I will add another animal to my herd." Overstocking and overgrazing was thus inevitable. Soil degradation and eventual desertification could be avoided only if all the pastoralists replaced their individual self-interest with "long-term preservation of the resource base as their first priority," perhaps requiring them to enter ranching schemes that privatized or strictly supervised access to pasture. The central task of this essay is to reconstruct M's modeling work. M's models, I claim, were shaped by his employing a range of resources, which included: the available computer compiler; available data; the short length of time both in the field and for the project as a whole; the work relations within the MIT team; the relationship of the United States and USAID to other international involvement in the region; the terms of reference set by USAID and the agency's contradictory expectations of the project. The task of interrelating the diversity of such resources raises serious methodological and conceptual challenges, which the counterfactual method developed in this paper begins to address. I also explore a parallel between M's work, the practices of the pastoralists themselves, and my reconstruction. We share the task of addressing ecological and social complexity together. At all three levels socio-ecologies have to be constructed.

"Feminist Tales: Review of The Total Devotion Machine and Other Stories by R. Love and The Recurring Silent Spring by P. Hynes," Science, Technology, and Human Values, 16 (4): 540-543, 1991.

"Pictorial representation in biology" Biology & Philosophy, 6:125-134, 1991. (With A. Blum)

Philosophical discussion of pictorial representation lags well behind analyses of verbal and textual propositions. The special issue of Biology & Philosophy, for which this essay is an introduction, aims to stimulate philosophers, and also historians and sociologists of science, to direct their attention towards the role and special characteristics of pictorial representations in biology, in particular, diagrams, graphs, and printed pictures. After reviewing the essays in the issue, we discuss two additional areas that are insufficiently explored in the essays and accompanying references: the historical development of conventions of pictorial representation in science, and the intertwining of visual and textual representation.

"Ecosystems as circuits: Diagrams and the limits of physical analogies" Biology &Philosophy,;6:275-294, 1991. (With A. Blum)

Diagrams refer to the phenomena overtly represented, to analogous phenomena, and to previous pictures and their graphic conventions. The diagrams of ecologists Clarke, Hutchinson and H.T. Odum reveal their search for physical analogies, building on the success

of World War II science and the promise of cybernetics. H.T. Odum's energy circuit diagrams reveal also his aspirations for a universal and natural means of reducing complexity to guide the management of diverse ecological and social systems. Graphic conventions concerning framing and translation of ecological processes onto the flat printed page facilitate Odum's ability to act as if ecological relations were decomposable into systems and could be managed by analysts external to the system.

The Ecology of Bishop Creek Brown Trout; Vol. II: Trout Population Model & Vol. III:Trout Population Model User's Manual. Reports by BioSystems Analysis, Inc. to So. California Edison, 1991. (With A. Small)

"Unfilled Holes in Conceptual Niche Space?" Book Review of Cherrett, J.M. (ed.). Ecological concepts: the contribution of ecology to an understanding of the natural world, Ecology 72(2), pp. 759-760, 1991

"Mapping ecologists' ecologies of knowledge" Proceedings of the Philosophy of Science Association 1990, Vol.2, 95-109

Ecologists, particularly those who consider socially generated effects in the environment, grapple with complex, changing situations. Historians, sociologists and philosophers studying the construction of science likewise attempt to account for (or discount) a wide variety of influences, which make up what historian Charles Rosenberg has called "ecologies of knowledge" (Rosenberg 1988). This paper introduces a graphic methodology, mapping, designed to assist researchers at both levels--in science and in science studies--to work with the complexity of their material. By analyzing the implications and limitations of mapping, I aim to contribute to an ecological approach to the philosophy of science.

"Developmental versus morphological approaches to modeling ecological complexity" Oikos 55:434-436, 1989

Although modellers intend their models to refer to some (conceivably) observable things, the impact of ecological models has come less from achieving tight correspondence with observations than from models' exploratory role, that is, from their helping ecologists derive new questions to ask, new terms to employ, or different models to construct. It is with the aim of stimulating further conceptual exploration by theorists and mathematical modellers that I have framed this rejoinder to DeAngelis and Waterhouse (1987; from here on, D&W).
;In their excellent review, D&W;present a schema of ecological modelling related to the issue of persistence over time of communities of species. Their starting point is an "equilibrium" view, in which systems move toward or away from a steady state. Increasing disruption from internal feedbacks or environmental stochasticity leads to emphasis on "biotic instability" or "stochastic domination," respectively. Accounting for the persistence of communities despite these disruptions leads D&W;to a "landscape" view, in which a community may persist in a landscape of interconnected patches even though the community is transient in each of the patches.
While endorsing most of D&W's;interpretations, this note draws an additional contrast, between a "morphological" approach to ecological modelling, in which complexity is analysed

in terms of its current configuration, i.e., as a "snapshot," and a "developmental" approach, which recognises that complexity can develop over time through the addition and elimination of populations (or other components). The developmental approach is not new, but it suggests pathways for exploration that have generally been overlooked or less travelled by theoretical ecologists and it raises the challenge of modelling complexity that has structure together with a history of structuring and restructuring.

"Mapping workshops for teaching ecology" Bulletin of the Ecological Society of America 70:123-125, 1989. (With Y. Haila)

"Connecting and extending our ecological science" was the title of a small workshop that we led at the University of Helsinki in April 1988. The workshop was motivated by two main issues: How can we steer our ecological science so it is not overspecialized but instead remains responsive and relevant to environmental concerns? How can we integrate the diverse yet partial theoretical themes prevalent in ecology? To address these issues the participants were guided 1) to construct "maps", that is, to define their key questions and trace the practical and theoretical connections on which they presently depend; and 2) to "revise" those maps and rethink their theoretical interests and research programs with three goals in mind: a) complementing the work of others in the workshop, b) responding to the needs of environmentalist social movements (e.g. in conservation and in sustainable development), and c) integrating interpretative themes from the "tool-box" developed by the workshop leaders. We cannot claim that the Helsinki workshop achieved all these aims or solved the two issues that motivated it. Nevertheless we consider the mapping workshop approach to have sufficient potential, both for teaching and for theorizing in ecology, to report on the approach at this early stage in its development. In this note we outline only the elements of mapping workshops and discuss how we used the approach to stimulate advanced students in defining their research. Mapping workshops also have potential applications for collaborative ecological theorizing, for examining the sociology of ecological science, and for on-going environmental assessment, but we leave discussion of these issues to a longer version of this article

---

"Revising models and generating theory" Oikos 54:121-126, 1989.

"Technocratic optimism, H.T. Odum and the partial transformation of ecological metaphor after World War 2" J. Hist. Biol. 21:213-244, 1988.

In October 1946 the Yale ecologist G. Evelyn Hutchinson (b.1903) delivered a paper entitled "Circular Causal Systems in Ecology" to an interdisciplinary conference at the New York Academy of Sciences (Hutchinson 1948). Hutchinson emphasized themes that would come to dominate ecology in the United States. In brief, he was exploring, as his title indicated, the concept of ecological relations as systems. This concept drew upon, but also made significant extensions to, the then prevailing organicist accounts of ecological complexity.
Hutchinson's paper provides me with a convenient starting point from which to trace conceptual connections and to characterize changes after World War 2 in the way ecologists in the United States studied ecological complexity. I subsequently move my focus to H.T. Odum (b. 1924), a student of Hutchinson's, who extensively developed his program during the 1950s and pioneered the field which has come to be known as systems ecology.

Organicism, undergoing a transformation into a systems view, was at the same time a source of social metaphor; ecological and social concepts are strongly connected in Hutchinson's and Odum's thinking. Their work allows me to highlight aspects of their social context, in particular, the "technocratic optimism" of the post-war years. The idea of technocratic management of society had a long history, but World War 2, particularly as it was experienced by scientists, transformed the character of that political fantasy. Government funding and organization of science under military imperatives produced significant results, giving currency to the belief that intervention on a large scale could be practically realized. Moreover, scientific control of complex systems seemed necessary to prevent further social upheavals or holocaust. Optimism about the benefits of such control overshadowed possible doubts about its implications for democratic political life.
The term technocrat has come to denote someone advocating technical approaches to social issues. The technocrat believes he can handle social complexity in a value-free manner, maintaining a distance from specific interests and political details, and through such non-dependency and disengagement he can best serve all. But it is typical of social philosophies framed in terms of universal interests that their proponents hold a special place in the proposed social organization. In my account I show that technocratic optimism facilitated H.T. Odum's early work in powerful ways; more than being the context of his work, technocratic optimism is constitutive of his concepts, methods and organization of research. This interpretation of Odum's transformation of metaphor for ecological complexity represents a partial reconciliation of strong externalist and realist interpretations of science. The realism, however, is not centered on the scientist's representation of nature but instead on the scientist's interventions within nature -- interventions which society facilitates in actuality, as possibilities, or as powerful fantasies.

"Glasnost?: Eyes Opening in the USSR" Science as Culture 3:124-132, 1988.

"The construction and turnover of complex community models having Generalized Lotka-Volterra dynamics" J. Theor. Biol. 135:569-588, 1988.

"Consistent Scaling and Parameter Choice for Linear and Generalized Lotka-Volterra Models Used in Community Ecology" J. Theor. Biol. 135:543-568, 1988.

"The Strategy of Model Building in Ecology, Revisited" 8th. Int. Congr. Logic, Meth. & Phil. of Sci., Volume 2:308-311, 1987.

"Historical versus Selectionist Explanations in Evolutionary Theory" Cladistics 3: 1-13,1987.

"Dialectical Biology as Political Practice. An essay review of R. Levins & R. Lewontin The Dialectical Biologist" pp 81-111 in L. Levidow (eds.) Science as Politics, Free Association Books, 1986.
"Community" pp. 52-60 in E.F. Keller & E. Lloyd (eds.) Keywords in evolutionary biology,Harvard University Press, 1992

Integrating the structure and dynamics of evolution's ecological context into evolutionary theory remains a neglected project. It is against this background that this entry reviews the approaches to ecological organization apparent in the different meanings given to the term community in ecology. My coverage is biased towards the United States and selected with an

eye to building a map of key theoretical positions, and not to presenting a survey of concrete results. The references I give (mostly reviews or compilations of essays) should enable readers to fill in the cast of actors, the biology of the organisms, and the other detail in historical and contemporary debates.

"A description with some applications of MSNUCY, a computer model combining interspecific interactions with nutrient cycling" Envir. Sci. Division Publication 2419, O.R.N.L., 1985. (With W.M.Post.)

"The Kerang Farm Model" Technical Paper no. 12 of I.A.E.S.R, 1979.

"Economic aspects of the use of water resources in the Kerang Region" Technical Paper no. 11 of the Institute of Applied Economic and Social Research (I.A.E.S.R.). (Second report to the Ministry of Water Resources, Victoria), 1979. (With J.Ferguson and A.Smith).

"Economic aspects of the use of water resources in the Kerang Region" First report to the Ministry of Water Resources, Victoria, 1978. (With J.Ferguson and A.Smith).

"Some computer programs for the analysis of genotype x environment interaction" Proc Int. Congr. Soc. Advances of Breeding Res. in Asia & Oceania, 3d(v.1):56-58, 1977. (With R. Eisemann, I.DeLacy and D.Byth).

"A new approach to the analysis of genotypic adaptation and genotype x environment interactions" and "A comparison of methods of analysis of GxE interactions and adaptation responses in a large data set" Proc Int. Congr. Soc. Advances of Breeding Res. in Asia & Oceania, 3d(v.1):16-22 and 41-46, 1977. (With R. Eisemann, I.DeLacy and D.Byth*).

Works in progress and selected presentations

"Notes towards guidelines about specific situations and specific ways in which specific technologies are of significant pedagogical benefit, " submitted to Connexions.
Although I use a variety of technologies in my teaching, I had not articulated my philosophy until I had to teach teachers about computers and education. I did not find a text that I resonated with and during the first semester began to develop my own guidelines. I cannot claim much success getting students to address my guidelines or to articulate their own pedagogical rationale for using computers. For the start of the second semester, I prepared a typically didactic powerpoint presentation to try to set the terms for the course. The collapse of the internet stockmarket bubble helped to create more space for critical thinking about the use of technology, but still I was not very successful in keeping students' sights on the education side of computers in education. I look forward to hearing thoughts from ISETA members about the comparison and guidelines to follow.

The Limits of Ecology and the Re / Construction of Unruly Complexity
© Peter J. Taylor
submitted to the University of Chicago Press. Editor: Susan Abrams

Comments welcome. Do not quote without permission of the author
excerpt from the INTRODUCTION

In this actual world there is... not much point in counterposing or restating the great abstractions of Man and Nature. We have mixed our labour with the earth, our forces with its forces too deeply to be able to draw back and separate either out. Except that if we mentally draw back... we are spared the effort of looking, in any active way, at the whole complex of social and natural relationships which is at once our product and our activity.
Raymond Williams, "Ideas of Nature"

Three Realms of Complexity

Ecology signifies many different things to people -- pollution, ozone holes, global warming, future catastrophe; green politics, recycling, simple lifestyles, unrefined foods; nature, biodiversity, endangered species; balance, interconnectedness, intricate co-adaptations among organisms and their environments. I have explored various trails in this forest of ecological concerns, some well-marked, others less so, particularly those into thickets I now associate with wanting to make sense of complexity. Ecologists often have to grapple with complex, changing situations -- even more so when researchers consider effects in the environment generated by society. How do these scientists make sense of the reticulating webs of ecological interactions in which organisms and people are entangled? This is a question I have come to see as not simply scientific, for when ecologists and socio-environmental researchers try to make sense of ecological complexity, they harness a wide variety of resources -- from funding opportunities to metaphors, from status hierarchies in their field to available sources of data. Therefore, to make sense of what scientists actually do in making their science requires interpretation, using perspectives from history, philosophy, sociology or politics. How do interpreters of science account for -- or discount -- the complexity of scientists' "ecologies of knowledge" (Rosenberg 1988)?

I have found it fruitful when studying complexity -- and studying how others study complexity -- to draw broad parallels between ecology and interpretations of science. In both realms systems are often conceptualized in a strong sense, that is, as units having clearly defined boundaries, coherent internal dynamics, and simply mediated relations with their external context. Observers can locate themselves outside the systems they study, and seek generalizations and principles affording a natural or economical reduction of complexity. I contrast this with an image of *unruly complexity*, in which boundaries and categories are problematic, levels and scales are not clearly separable, structures are subject to restructuring, and components undergo ongoing differentiation in relation to each other. Control and generalization are difficult and no privileged standpoint exists. Well-bounded systems, when they are encountered, require explanation as special cases.

Unruly complexity is not like the situations emphasized in recent complexity theory where simple rules lead to complex behaviors. Nor does it involve macro-regularities arising statistically from large numbers of similar entities, so long-standing physical and chemical theories in that vein, such as thermodynamics, are no guide. Indeed, unruly complexity is not well explained by traditional approaches in the natural and social sciences, which reduce, bound, and system-ize ecological or ecological-like complexity. The challenge I address in this book is to move readers beyond the *limits of ecology* -- to open up the boundaries that have been drawn to circumscribe the diversity of interactions, and to overcome the limitations of knowledge derived from studying those circumscribed interactions. Scientists and other

researchers need, I believe, to find ways to respond to the unruliness of complexity without suppressing it.

In ecology and in interpreting science I have come to see complexity as *constructed*. Just as a house is built over time using plans and measurements, laborers and contracts, concrete and concrete mixers, wood and saws, complexity is produced over time by combining diverse components and processes, that is, through *heterogeneous construction*. When scientists and other scholars harness many diverse resources in establishing knowledge, their efforts are necessarily practical as well as intellectual. Knowledge construction in practice is necessarily bound up with other construction -- of lives, careers, institutions, language, ideologies, societies -- that is, with a range of actions and *engagements*. The scientist's ideas, therefore, can be interpreted with reference to the actions that the ideas facilitate, that is, by attending to the *agency* of researchers. And, interpretations are also constructed -- what holds for scientists also applies to researchers who interpret science.

In this light, *reconstruction* becomes a conveniently ambiguous term. It can refer to an interpreter's account of the scientific construction processes, but can also be applied to efforts to modify those processes as they continue into the future. Both kinds of reconstruction can be undertaken by scientists and interpreters of science who take their agency seriously and self-consciously. To do so requires models of agency, of how researchers -- myself included -- can be concerned with ideas, models, and representations at the same time as with change, action, and engagement. The challenges of self-conscious reconstruction constitute the third realm of complexity addressed in this book. In this spirit, let me provide some personal context, which prepares the ground for the narrative in the chapters ahead that links the various case studies and casts them as episodes in my developing and ongoing inquiries.

I trace the origin of my explorations of how researchers deal with complexity to environmental activism in Australia in the early 1970s. I wanted not only to respond to existing environmental problems but to help plan to prevent future ones emerging, so I chose to combine my studies of ecology with mathematical modeling and quantitative analysis. Modeling soon led me to the nascent field of theoretical biology, which catalyzed a wider interest in ways that biological inquiries are framed. Better theories of ecological complexity might guide planning, but I also sought affirmation from science of the egalitarian, decentralized, and environmentally conscious society I advocated.

It was in agriculture not environmental planning, however, that I found employment. I was hired to extract patterns from the complexity of interactions between plant varieties and field conditions in large crop trials. Later I modeled the economic future of an irrigation region suffering from soil salinization. The government sponsors of this study turned out to be interested only in a small subset of the factors and policies potentially relevant to the region's future. Frustration with the constraints on this research led to more general questions about the social shaping of science.

By this time I had heeded the lessons of Raymond Williams in his essay "Ideas of Nature" and learned not to look to nature, correctly theorized, to affirm my social principles. Yet I maintained an interest in connecting science and social action. This interest had been stimulated by my undergraduate thesis advisor, Alan Roberts, a physicist who also wrote about environmental politics and the need for the self-management of society (Roberts 1979). In

1979 I sought the opportunity to work with Richard Levins and Richard Lewontin after I learned that these two American biologists, whose theoretical work I already knew and valued, saw their scientific work as a political project (Levins and Lewontin 1985; Taylor 1986). In graduate school with them and subsequently I have studied interpretations of science in its social context at the same time as undertaking research in ecology and socio-environmental science. Working jointly on these fronts has allowed me to pursue the possibility that interpretations of science can feed back into changing science -- thus the third realm of my inquiry into complexity.

Early on in these explorations of constructed complexity, I took from the anthropologist Eric Wolf an alternative image to that of strong systems. Systems or structures -- in his work societies or cultures; in ecology, ecosystems or communities -- could be seen as contingent outcomes of intersecting processes that involve diverse components and span a range of spatial and temporal scales (Wolf 1982). This perspective was evident in research that emerged in the late 1980s in the field of political ecology, where cases of environmental degradation were explained in terms of linked changes in local agro-ecologies, labor supply and the organization of production, and wider political-economic conditions (Peet and Watts 1996a). During the same period I was stimulated by sociologists of science who highlighted scientists' heterogeneous resources and who encompassed many kinds of activities within their concept of scientific work (Law 1986; Latour 1987; Clarke and Fujimura 1992a). In thinking about self-conscious or reflective engagement with ecological and social complexity, I encountered and was inspired by participatory action researchers who shaped their inquiries through ongoing work with and empowerment of the people most affected by some social issue (Adams 1975).

Indeed, the picture that began to emerge from my efforts to integrate the three realms of complexity could be expressed as a generalization of Participatory Action Research to ecological research and interpretation of science. The study of any complex ecological or environmental situation could be re-conceived and re-organized with the goal of linking knowledge production, planning for action, and action in an ongoing process. Interpretation of the social situations in which the environmental research is undertaken warrants an equivalent participatory process. Thus, in response to developments -- predicted and surprising alike -- reflective researchers could continually reassess their knowledge, plans, and action, and the engagements that make those possible.

Once I had that image in mind, I struggled with significant conceptual and expository tensions. I wanted to highlight the practical and action considerations that researchers build into their representations, but this emphasis also meant that argument and textual exposition could have only limited power to move readers. I hoped my case studies would motivate a number of general propositions and questions, but one of these propositions was that the impact of general themes depends on the ways different researchers link them with diverse other resources as they negotiate their particular contributions within specific fields. I recognized that each additional realm of complexity I addressed increased the range of relevant social agents and the possible points at which they might engage and reconstruct, but completing "my book" would hardly exemplify an ongoing participatory process of changing knowledge, society, and ecology.

Obviously, I did not give up on the book. But, as will become evident, the result reflects the shift in my work to a more self-conscious focus on teaching critical thinking and learning to foster reflective practice (Taylor 1999b). Of course, like any expository author I want readers to

follow the steps I take and appreciate the position I lead them to. At the same time, the propositions, questions, and puzzles I present along the way are meant as food for readers to chew on even if they cannot (yet) digest the main course. Under either reading, however, The Limits of Ecology is constructed to point to further work needed in "looking in [an] active way, at the whole complex of social and natural relationships which is at once our product and our activity."

"Fostering critical thinking through attention to the inter- and intrapersonal," Center for Excellence in Teaching and Writing, Oregon State University, February 2001.

In this two-hour workshop participants will be able to explore three teaching/learning themes:
i) Critical thinking as a personal journey into unknown areas or where one sees known areas in new light;
ii) Clearing mental space so that thoughts about an issue in question can emerge that had been below the surface of our attention; and
iii) Respect for the variety of perspectives, styles of learning, and dispositions for critical thinking.

"Exploring heuristics about social agency through interpretation of diagrams of nature and society," for How Does Nature Speak: Dynamic Understandings, ed. Y. Haila and C. Dyke

The ecologist and social critic Richard Levins has suggested that policy changes should be evaluated in terms of thei effects on small children. Such a suggestion is intended to stimulate our thinking, open up question, and orient our inquiry. It is a heuristic, and like all heuristics, we expect it to misdirect us at times.
This essay examines heuristics concerned with the study of social and environmental dynamics, including the ways researchers position themselves in changing those dynamics -- their social agency. The particular heuristics considered are drawn from my interpretations of diagrams that various researchers have made of the relationship between nature and society or between natural and social processes. Although these heuristics and the interpretation of diagrams are intended to be stimulating, a deeper analysis woudl consider detailed cases of social-environmental analysis and interpret researchers' work with reference to the full text and context surrounding the diagrams. The essay as a whole, therefore, is offered in a heuristic spirit.

"The hidden complexity of simple models, or Why theorists of all kinds should be troubled by unmodeled variables having dynamical lives of their own, " For T. Auerbach (ed.), Complexities Of Life: Ecology, Society and Health

Can ecological theory generate principles that could be usefully generalized across ecological situations? Particularism has been a perennial attraction in ecology, but a new source of doubt gained momentum by the end of the 1980s after theorists started looking at "indirect interactions" -- effects mediated through the populations not immediately in focus, or, more generally, through "hidden variables" that have their own dynamics. How much do indirect effects confound principles derived on the basis of observing the direct interactions among populations? My exploration of this question should challenge not only ecologists, but theorists in all fields that make use of models of any kind of sub-system elevated from the complexity in which the sub-system is actually embedded.

"We know more than we are, at first, prepared to acknowledge: Critical thinking as journeying"

Exponents of critical thinking emphasize the teaching of skills and dispositions for scrutinizing the assumptions, reasoning, and evidence brought to bear on an issue by others and by oneself. In short, they promote thinking about thinking. But how do students come to see where there are issues to be opened up and identify them without relying on some authority? The current form of my evolving "answer" is that people need support to grapple with inevitable tensions in personal and intellectual development -- support to undertake journeys that involve risk, open up questions, create more experiences than can be integrated at first sight, require support, and yield personal change. In this essay I present five passages in a pedagogical journey that has led from teaching undergraduate science-in-society courses to running a graduate program in critical thinking and reflective practice for teachers and other mid-career professionals. I have shaped these passages to expose some of my conceptual and practical struggles in learning to decenter pedagogy and to provide space and support for students to develop as critical thinkers. The key challenge I highlight is of helping people make knowledge and practice from insights and experience that they are not prepared, at first, to acknowledge. In a self-exemplifying style, each passage raises some questions for further inquiry or discussion. My hope is that the essay as a whole stimulates readers to grapple with issues they were not aware they faced and to generate questions beyond those I present.
See full text of an earlier draft

"Process and product in the generation of environmental knowledge and inquiry"

Since the late-1980s many accounts in the social studies of science and technology (STS) have discussed establishing scientific knowledge and the effectiveness of technologies in terms of heterogeneous resources mobilized by diverse agents spanning different realms of social action. In the environmental arena such "heterogeneous construction" (Taylor 1995) is, in effect, self-conciously organized through the frequent use of workshops and other "organized multi-person collaborative processes" (OMPCPs). This essay describes my own process of making sense of the workshop form for generating environmental knowledge and further inquiry. This process was catalyzed by participating during the spring and summer of 2000 in four innovative, interdisciplinary workshops. By reflecting on these workshops and drawing on other experience I identified six angles for thinking about why a workshop (or OMPCP) might be needed to address the complexity of environmental issues. The angles relate both to establishing knowledge ("product" in the paper title) and to developing the capacity for further inquiry ("process") through participation in OMPCPs ("process"). I used the six angles to review the four workshops. This led me to dig deeper into how workshops work when they do and assemble a list of heuristics and some open-ended questioning. One of these heuristics, as will become evident shortly, involves making space for the audience to bring their own knowledge to the surface. One member of the audience for my first presentation on this topic offered to help me develop a more systematic set of principles for bringing about successful workshops. The outcome makes up the final section of this essay, and the basis for further inquiry on workshops and the process-product relationship more generally.
See full text of earlier draft

"Genes, gestation, and life experience: Environmental complexities in the age of DNA"
I have begun to examine the development and reception of three areas of epidemiology. (I use this term broadly to denote research that correlates traits in general, not only disease incidence, to antecedent factors in defined populations and attempts to determine the causal processes by which the traits develop over time.) Each approach complicates the persistent, albeit often qualified, contrasts: inborn and unchangeable versus environmental and changeable; and biological versus social. The areas are:
1) Research on gestational programming, which has identified associations between nutrition during critical periods in utero and diseases of late life, including heart disease, diabetes, and death by suicide;
2) Life events and difficulties research, which has exposed relationships between severe events and difficulties over a person's life course and the onset of mental or physical illness (Harris 2000); and
3) "Reciprocal causation" models of IQ development in which there is a matching of traits and the changing environments in which traits develop so as to allow both high heritability and large gains from one generation to the next.
In this essay I do not delve deeply into any of these approaches, but provide an introduction and overview sufficient, I hope, to bring more attention to the complexities of the "environment" and to the ways scientists account for the development of behavioral and medical conditions over any individual's lifetime. As part of exploring the significance of the three approaches, I identify various ways that they challenge each other as well as challenging more traditional accounts of gene-environment interactions from behavioral geneticists and from critics of biological determinism.

"Re/constructing social agency (and other important things) in the diagramming of social-natural processes" (with Chris London)

This paper exposes and opposes discursive idealizations and promotes new efforts at representing and intervening in the complexity of social-natural processes. We identify six aspects that are suppressed in most accounts of society and nature, or, at least, dealt with awkwardly: the inseparability of nature from society; social agency, which includes the agency of both the humans represented and the representers themselves; the differentiation among unequal agents implicted in social-natural processes, the heterogeneity of elements and scales, the historical contingency of the processes, and their structuredness.
We focus on diagrammatic representations, examining a range of diagrams in order to characterize the pictorial conventions, representational technologies, cognitive considerations, theoretical heuristics or preferences, and discursive interventions (or modes of "representing-intervening") that are brought into play in representing or obscuring the six key aspects of social-natural processes. In addition to interpreting diagramming, we promote experimentation in the use of diagrams of "heterogeneous resources" and of "intrasecting processes." Our goal is not simply to represent differently, but to facilitate self-conscious, reflexive "intraventions" in a world whose dynamics are characterized by the six aspects. In illustrating our points and proposals examples are used from the areas of political ecology, systems ecology, landscape restoration, and science studies. Our discussion should be of relevance to those who study visualization in science, and also to social theorists and a broad range of analysts of social-natural processes.

"Unruly complexity and a critique of the concept of system in ecological theory," Santa Fe

Institute, November 1993.

Ecologists and environmental scientists, particularly those who consider socially generated effects in the environment, have to grapple with complex, changing situations. In what ways can we make sense of ecological complexity? My work in theoretical ecology has led me to hold an image of "unruly complexity"; this contrasts with dominant "system-like" representations in ecology (and elsewhere). My work in history and sociology of science has also led me to understand the dominant systems as privileging technocratic and / or moral practices or interventions in the world.
The contrast I am drawing is as follows: At one pole lie views and approaches that construct from ecology and from society natural units, "systems" in the strong sense of having clearly defined boundaries and coherent internal dynamics governing their development, structure and stability, and their adaptation to external influences. Observers can thus locate themselves outside the systems studied, and seek generalisations and principles affording a natural reduction of complexity. At the other pole, we find analysts grappling with historically contingent situations resulting from intersecting processes, in which boundaries and categories are problematic, levels and scales are not clearly separable, and structures are subject to restructuring. Differentiation and change, not adaptation or equilibrium, characterises these situations of "unruly complexity." Control and generalisation are difficult and no privileged standpoint exists; in fact, the boundary between scientist and engaged participant can hardly be maintained. I want to reinforce and stimulate interest in work on complexity that moves us towards the second pole. The spirit of the Santa Fe Institute seems to pull in the other direction. Is that so? Is that OK?

"What's (not) in the mind of scientific agents?: Implicit psychological models and social theory in the social studies of science"

When describing how scientists secure support for their scientific theories, Latour and Callon (L&C);use the semiotic label actants for human, other living beings, and non-living things alike. The playfulness of the resulting anthropomorphic accounts seems to animate the discussion of the non-human resources, but in practice the accounts reduce everything to a lowest common denominator, dulling the analysis of human purposes, motivations, imagination and action. Beginning with L&C's work, I examine the implicit models of the psychology of scientists that prevail in the social studies of science (SSS) and conclude that SSS's scientific agents tend to be those who act with a minimal psychology, almost without mental representations. This ensures that inborn dispositions, cognitive constraints, individual creativity, and so on, cannot determine action and belief, thus preempting those who invoke the internal cognizing mind to resist the social construction of science. Psychology of agents is, in turn, an arena in which to argue about social causality, about the structuredness of society and the role of agents in its re / production. L&C's;behaviorism, for example, leaves no place for interests or other external influence to reside inside the scientist's head, and thus counters earlier analyses that allows social context or forces to determine their beliefs or actions.
This essay does not, however, claim to establish tight connections of different SSS methods to models of the psychology of agents and to social theory. Instead, connections among the three areas are proposed in a heuristic spirit. Thinking about each of the three areas is animated by the attempt to draw connections to the other two. At the same time, because the resulting propositions will not refer to all the details of any particular SSS method, they are made in the expectation of provoking responses from the methods' proponents. Through these responses

more of the diverse conceptual and practical resources that different SSSers employ would be revealed. I finish by interpreting my own method in light of a model of agents as imaginative, heterogeneous constructors. This model of distributed psychology and social causality constitutes an alternative to both contextual determination and autonomous agency, and deserves more attention.

"Apparent interactions in community models"

Over the last decade community ecologists have become concerned about "indirect interactions": Do the effects mediated through the populations not immediately in focus, or, more generally, through "hidden variables," confound any principles or results derived on the basis of observing the direct interactions among populations? In this paper I introduce a puzzling anomaly whose resolution speaks to this question and to the meaning of models of sub-communities elevated from the ecological complexity in which they are embedded. "Apparent interactions" (the term I use for the sum of direct interactions within the sub-community and indirect interactions from hidden variables) are troubling in ecology because the hidden variables have dynamics of their own; controlling them is not a relevant strategy for understanding naturally variable and complex ecological situations. Apparent interactions ought also to trouble philosphers studying scientists' strategies of using heuristics, of model building, decomposition and localisation, and reduction.

Contents pages for: All courses | Portfolio | the Next Course-->

Thinking, Learning and Computers

(CCT670)

(9/99 -- see appended 9/01 update)

Initial Goals

My goal was to create a course about computers and education for both CCT and M.Ed. students. (I thought, mistakenly, that this would be the only computers and education course.) For the first six classes I designed activities to acquaint students with a number of specific computer-based tools, and at the same time to lead into critical thinking about these tools. On that basis, the second half of the course would examine interpretations of and debates about social and educational transformations that involve computers. The different class activities were intended to provide models for adaptation to classes and other settings. In addition to their projects, students also prepared briefings on selected topics for each other, which is one way they can address the explosion of information made possible by computers (see syllabus from Fall 1998).
This course was established by a former CCT director who believed that research on computers and artificial intelligence provided insight about processes of human cognition, thinking and intelligence, and thus about learning. I do not share that belief, and attempted to provide the conceptual and socio-historical background to support a critical position on computers as models for thinking and learning.

Challenges and Responses
I learned quickly that the M.Ed. students thought the course would provide direct instruction about use of computers and software in their classrooms. Some withdrew; those who stayed still wanted more hands on time on computer-based tools than I had planned. Most students needed more warm-up than I gave them to appreciate "critical and creative thinking," the expectations of reflection pieces, the rationale for the unconventional assessment system, and the value of revising and resubmitting in repsonse to my comments. Nevertheless, M.Ed. students proved able to choose a classroom oriented project or a more critical paper as it suited their interests.

A turning point in the course was a mid-semester class in which I was away at a conference.

The students brought in movies cued to a scene highlighting changing social attitudes about computers and had to interpret their scenes to the other students, something I had modeled the previous week. Having to take full responsibility for their own learning had a positive impact on students' engagement in the remaining classes, something they acknowledged in the historical scan during the final class. Unfortunately, activities during the final class to take stock of the course left insufficient time for most students to complete either the GCOE evaluation or the one I had prepared. Follow-up requests yielded more returns, but the number of evaluations received was too low to be representative.

Future Plans

My plans for future offerings of this course are to:
--maintain the hybrid CCT-education nature of the course, and to direct the more pragmatic or anxious M.Ed. students to the other courses;
--rearrange and adjust the early classes so the course begins with the students experiencing computer use from the position of students, not teachers. The aim here would be to make non-CCT students comfortable by establishing a basis in the concrete before moving on to critical thinking about computer-based tools and, later, to interpretations and wider debates about computers in society;
--address the emerging challenge of using the World Wide Web well, in particular for distance education, by starting with a hands-on class related to this topic;
--maintain the CCT emphasis on critical reflection, but with streamlined requirements, instructions, and assessment system;
--require conferences with me early in the course for students to express their concerns and for me to establish dialogue needed to support students' development as critical thinkers;
--encourage M.Ed. students to undertake course projects on their specific educational interests;
--continue to collect clippings on developments in computers and organize them in a binder to stimulate students thinking about their projects and my own thinking about possible changes in the course;
--provide handouts on class activities to facilitate their adaptation into students' lesson plans (a practice already begun by the end of the fall 1998 semester);
--rework the two most difficult classes (on dynamical systems and heterogeneous construction); and
--time the final class so evaluations are submitted before students leave on the last day.

Update

9/01
CCT670 was not taught when scheduled in Fall 2000 because I received a course release under a Healy grant. Many of the future plans above, however, are reflected in the syllabus for Ed610 in Spring 2001.

Contents pages for: this Course | All courses | Portfolio | the Next Course-->

Contents pages for: <--Previous Course | All courses | Portfolio | the Next Course-->

Practicum: Processes of Research and Engagement

(CCT698, Fall 98, 99, 00, 01)

(9/99 -see appended 9/01 update)

Initial Goals

This course is based on a research course I taught several times in which undergraduate students investigated issues that concerned them about the social impact of science or about the environment--issues they wanted to know more about, or advocate a change. CCT students would instead focus on current social or educational issues, but, as in the previous course, they would be guided through different stages of research and action--from defining a manageable project to communicating their findings and plans for further work. The classes would run as workshops, in which students are introduced to and then practice using tools for research, writing, communicating, and supporting the work of others. To keep students moving along in their research, there would be many small writing assignments on their projects, with requests to revise and resubmit in response to my comments.

The emphasis on process, not simply the production of the final paper/report, makes room for confronting personal, psychological issues that usually arise around defining one's own work and convincing others of its significance. The course description, overview, assessment system, and expectations listed in the Fall 1998 syllabus spelled out my initial teaching/learning approach in this course.

On a practical level I had to condense the two 2 hour sessions from the earlier course into one 2.5 hour session.

Challenges and Responses

This has been my most challenging course to date at U. Mass. Five of the eleven students were very product-oriented, some of them because they were simultaneously completing their capstone projects on the same topic under a timetable that allowed little room for new exploration. Four of the five viewed the assignments, tasks, and requests for revision as getting in the way of doing what they knew how to do, completing a research paper. My use of illustrations from previous classes did not help them see the value of new steps along the

way‹these classes consisted of young undergraduates from elite colleges, not adult learners like themselves. The four did not engage productively in the workshop activities, assignments, or revision. Most seriously, they avoided talking to me about the approach they were taking to the assignments and the course in general.

Although the full picture became clear mostly only in retrospect, I did realize during the semester that I needed to talk more with these students. However, I found it difficult, given the busy-ness of their lives and mine starting a new job, to make times when this could happen, or to follow up when appointments were missed. I now include a requirement of at least two conferences in all my courses, one of these early on before misunderstandings of course goals become fixed in a student's head.
During the semester, I also responded to expressions of "confusion" about what was expected in two ways:
i) producing a summary of the iterative, overlapping phases of "research and engagement." (This has since evolved into a structure reflected explicitly in the Fall 1999 syllabus and is reflected in the subtitle I have added to the course.); and
ii) by structuring my weekly handouts so they began with a summary of "Assignments due," "Tasks in preparation for class," "Other tasks," and "Follow-up and feedback," and followed this by details about item. After the semester, I digested my experiences and feedback and produced detailed "Notes on Teaching/Learning Interactions," which I now include in the course packet for all my courses. Including such material in the course packet also accommodates to students who want details in advance of future assignments and allows weekly handouts to be much simpler. I still need, of course, to draw students attention in class to the numerous tasks and assignments ahead, and to convey their rationale.
I do not, however, believe that the added written material would have "won over" the four students who resisted or rejected what the course offered. In addition to making more time to talk with students, I decided this fall to:
i) focus on producing the "dialogue around written work," as articulated in the Notes. (My efforts to achieve this will be illuminated by peer observation and reflection during this fall's faculty seminar on "Becoming a teacher-researcher.");
ii) include in the course packet examples from the previous CCT course (not the pre-UMass courses); and
iii) invite to the first class an alum from the previous course to be interviewed by the new students. This appears to have been an effective "innoculation" against students proceeding as they always have and focusing on the end of semester deadline for submitting a report/paper. (I think I can always expect product-orientation to be a default option for some CCT students, many of who have busy work lives and would not have chosen the CCT Program if they were not so headstrong.) There are again two Practicum students undertaking their capstone projects, but I worked with them through much of the Practicum process during the summer. Their role in the Practicum classes, when they can attend, will be to coach the others.

Fortunately, a number of students in the Fall of 1998 appreciated the course process, experimented with the tools I was introducing, and made significant progress. Even so, it was difficult to lead students beyond library research and to pilot implementations of the classes or workshops many envisaged. In the third class this fall, in order to model what is possible, I have scheduled a demonstration by an alum of her curricular innovation.

Future Plans
In addition to the changes above already being implemented, I am working (via advising, the CCT handbook, and notes to other advisers) to ensure that CCT students take the Practicum

before they undertake their capstone projects. I am also exploring the range of other research courses in the GCOE with a view to allowing students to cross programs if another course matches their needs better.

Update
9/01

I have implemented all the plans listed above and the students' evaluations show that they appreciate, without exception I think, the process emphasis of the course. My teacher-research during the Fall '99 C.I.T. faculty seminar allowed me to acknowledge the tensions facing students in taking themselves seriously as lifelong learners (see report in new exhibits). I have articulated a set of ten process goals to complement the "product" goals of the ten "phases of research and engagement" around which the syllabus and course packet (see new exhibits) are structured. I continue to adjust the format of the syllabus and course packet to help students find their way into them when needed‹they are not intended to be digestable at first sight.

The most significant outstanding issue is that not all students complete the written assignments, revisions, and the final report. This has worked against them and caused headaches for their advisors when the students have proceeded to undertake their synthesis projects. In Fall 2001 the question I have set for teacher-student-research is: "By what means can the group function as a support and coaching structure to get most students to finish their reports by the end of the semester?"

The other challenge for the future is to engage other faculty members‹at UMass and elsewhere‹in discussion about integrating inter- and intra- personal reflection into the teaching of research and writing. As much as I have turned away from didactic presentations of method, I know that there are currents in qualitative research that could inform my teaching and writing about this teaching.

Contents pages for: <--Previous Course | this Course | All courses | Portfolio | the Next Course-->

Contents pages for: <--Previous Course | All courses | Portfolio | the Next Course-->

Critical Thinking

(CCT601, Sp 99)

(taught with A. Millman)

(9 / 99)

Initial Goals

This is a required CCT course and is also taken by many M.Ed. and doctoral students as an elective in critical and creative thinking. I had not taught a course like this and expected this would be an opportunity for me to learn from my co-teacher approaches to critical thinking established in philosophy and, to a lesser extent, in psychology. I expected to insert only one or two new classes based on my personal approach to critical thinking, which is to place established facts, theories, and practices in tension with alternatives so one can see how things could be otherwise. However, my interest in students learning through activities, not only through discussion, led me to invent activities for many of the classes, especially when I discovered I was familiar from other contexts with the author or their themes. Arthur Millman was willing to try out other changes I suggested for the course, such the "revise and resubmit" assessment system, the manifesto assignment, the critical incident questionnaires, thought-pieces extracted from students's journal, and the "Notes on teaching / learning interactions" I had prepared after teaching the fall courses.

As a result of our pre-semester discussions, we defined the following overall goals, which had not been expressed in quite this way before. We wanted course participants to:
1. appreciate and reflect on the range of views on critical thinking, contrasts and tensions among those views, and the evolution of the field toward increasing attention to the social context in which thinking takes place;
2. work new views, skills, and model lessons / group activities into practices of thinking, learning, teaching critical thinking to others, and finding support for change (see 3);
3. develop support to understand 1 and sustain 2 beyond this course, especially the support that derives from having active conversants, appreciative listeners, and dialoguing around written work.

Challenges and Responses

Early on some students raised their misgivings about working in small groups--could they trust others; was this an exercise in "mutually shared ignorance? Some students wanted the class to be smaller so they could have more direct interaction with the professors and whole class discussions. Cutting the class size was not an option and in "whole class discussions," of which we had some, fewer voices are heard. Instead, I reviewed other people's guidelines for small group discussions and developed ones for the course based around four roles (facilitator, initiator, timer, and reporter). These roles were not always well followed. In the future, we should model and give explicit training at the start of the semester.

As the course developed, however, listening became a significant theme. Classes 7, 8, 9 and 11, which introduced various approaches to listening, were very popular. During this phase of the course students who had been quiet or lacked confidence in their ability to think critically started to articulate connections between critical thinking and their work as teachers and professionals. On an intellectual level, it appeared that listening well allows one better to tease out alternative views. Without alternatives in mind there is little motivation to question the support for one own view, and to follow critical thinking dictates to examine evidence, hidden assumptions and logic.

Dialogue also became a recurrent theme of the course. Several times Arthur Millman and I exposed and explored different perespectives through dialogue in front of the class. Some students were disconcerted by our apparent differences; others valued them. More generally, we noticed that some students wanted us to provide clear definitions of and procedures for critical thinking and for particular assignments and activities, while others were more comfortable grappling with the tensions among different approaches. We responded at times to anxieties by preparing mini-lectures and handouts, but we also persisted in conducting activities and promoting journaling through which students might develop their own working approaches to critical thinking. This tension was most evident around the manifesto assignment, which asked for a "synthesis of elements from the course selected and organized so as to inspire and inform your efforts in extending critical thinking beyond the course." This was a new assignment so we could not provide examples from previous classes. I responded to students queries about the assignment by distributing my draft manifesto. Eventually, however, almost all the students had become confident enough to compose their own, often quite personal, syntheses. In future years, we will be able both to provide examples and to convince students that they'll see how they want to compose their manifesto by the time it is due at the end of the semester.

In the class on remodeling lesson plans, we reviewed the first class of the course. This helped me to articulate the primary message of a story and demonstration I had presented, namely, that the development of critical thinking is like a journey. I went on to use this metaphor in a faculty development workshop last June, and would do so in future offerings of this course. It corresponds well to the three goals we defined for the course (see above) and would allow us to further develop the intra- and inter-personal dimensions that have been insufficiently explored in critical thinking texts and courses.

Several other items to address emerged during the course and from the course evaluations. These are summarized in my "to do" list.

Future Plans

Unfortunately, scheduling considerations may mean that I will not teach this course again in the next few years. In the meantime, however, I am collecting material material on current controversies to develop into critical thinking activities and am looking for opportunities to

synthesize and publish something about the role of listening, dialogue, intra-personal reflection, and the journey metaphor in fostering critical thinking.

Contents pages for: <--Previous Course | this Course | All courses | Portfolio | the Next Course-->

Contents pages for: <--Previous Course | All courses | Portfolio | the Next Course-->

Science in Society

(Seminar in Critical Thinking, CCT611, Sp 99)

(9/99 -- see appended 9/01 update)

Initial Goals
This seminar was based on case studies and activities from an undergraduate "Biology and Society" course I had taught several times. My goals were to adapt it to the CCT/GCOE setting, by leading students to
address the course material on a number of levels: as an opportunity to learn the science and interpretive approaches; as models for your own teaching; and as a basis for discussions about practices and philosophies of education, construed broadly as a project of stimulating greater citizen involvement in scientific debates.
To this end I was more explicit than I had been before about my conceptual and pedagogical themes (see "Overview of course themes").

Challenges and Responses
The students' prior training in biology was varied and, with one exception, not recent. As a consequence the class meetings operated mostly on the first level. In any case, more than 2.5 hours per week would have been needed and/or fewer topics, in order to make room for serious discussion of teaching and educational philosophy.

Future Plans
Over the next few years I plan to prepare the cases for a book and website. While doing so I expect to see ways to fashion classes that would fit in the time available and to prepare reading material that brings students up to steam in the relevant biology. As I develop new cases, e.g., one on gestational programming, I will have to drop others. I intend, however, the mix of cases to cover the four broad angles of interpretation, namely, "scientists' historical location, economic and political interests, use of language, and ideas about causality and responsibility." I also plan to emphasize the lesson plan option for students' projects, which will, I expect, stimulate more discussion of teaching and educational philosophy.

Update
(9/01)
For implementation of these plans in my science-STS teaching, see CCT640, Environment,

Science, and Society (Sp 01) and CCT611, Making Sense of Numbers (F 01)

Contents pages for: <--Previous Course | this Course | All courses | Portfolio | the Next Course-->

Contents pages for: <--Previous Course | All courses | Portfolio | the Next Course-->

Seminar on Evaluation of Educational Change

(CCT693, Sp 00, 01)
(previously Seminar on Educational Evaluation, CCT685, Sp 99)

(9/99 -- see appended 9/01 update)

Initial Goals

Although I had experience in social research and statistics, evaluation of educational change was a new area for me as a teacher. I designed the course so that I learn as much as possible by leading students to digest the texts for themselves and for each other, coaching the students in mini-projects, and facilitating participatory planning and other group processes. This last aspect would serve two functions: the syllabus could be adjusted according to students' background and interests, and students would be introduced to the larger endeavor of working with other people in implementing and improving educational changes. In this spirit, I chose texts that emphasized the relationship between evaluator and sponsor from the formulation of questions onwards needed if outcomes are to be taken up in changes in practice and policy.

The mini-projects were based on clippings and short articles I had collected concerning evaluations undertaken or needed.

I decided not to schedule a sequence of classes on quantitative methods but to encourage students to formulate questions based on the articles they were reading and to coach them in securing statistical advice from skilled practitioners.

Challenges and Responses

Future Plans

I have mentioned some of my future plans in the preceding section. I have a larger "to do" list stimulated by the formative and summative evaluations of students in the course, and their participation in revising the course as we went. My other major goals for the future are to:

--expand some of the clippings into well developed cases, especially in the areas of science education;
--consult with other GCOE faculty with a view to differentiating the evaluation and research courses we offer; and
--build on the mini-project of one student last spring to push for more productive forms of course evaluation in GCOE.

Update
(9/01)

I have continued to experiment and develop this course in the direction of evaluation being not an end in itself, but as a tool of educational change‹or, for the non-educators in CCT, of organizational change. The students learn and practice tools for facilitating groups and building constituencies for the educational changes the students want to evaluate or propose. This development is evident in the changing syllabus‹especially the extended course overview‹and in the course evaluations I used to focus student input on those changes.

In spring 2000, I inserted a participatory planning process before the middle of the semester, with the goal of students "support[ing] each other to get competent and comfortable in evaluating and facilitating educational change." It challenging for me to cede control to the students, and it proved difficult for the students to take responsibility for the tasks planned by the task forces. From an email exchange at the start of the process:

Date: Tue, 7 Mar 2000
From: peter.taylor@umb.edu (peter j. taylor)
Subject: for CCT693: ex-captain's log, stardate 7 Mar. 5.45am EST

Journal entry:
Woke early with lots of suggestions for the feedback, clarity & coordination task force, especially re: getting other task forces to be clear about who is responsible for making their proposed actions happen and providing the clear rationale for them.
Impressed by the seriousness and energy of the taskforces last night.
Excited by this, but also noticed myself (as teacher) wondering if you'll cover what "needs" to be covered in a credible course and whether it'll fit together in a way that satisfies everyone. In short: Yikes -- I'm not in control!
Peter

From: "joelle barton"
To: "peter j. taylor"
Subject: Re: for CCT693: ex-captain's log, stardate 7 Mar. 5.45am EST
Date: Wed, 8 Mar 2000

Hello Captain: I think it would be okay to pull back some on the control, after all you do outrank us. Seriously, CCT supports works in progress for the students, why not for the teacher, too? Joelle

Students' responses to the experiment were vocal and varied (see written comments on course evaluation). Interestingly, the Leadership in Urban Schools doctoral students were most in favor of an explicit and settled syllabus. What I experienced most strongly was the difficulty of alternating between teaching and facilitating. Even when I literally changed hats, students saw my facilitation through the lens of knowing that I was also their teacher and leader (see

"Alternating...," conference paper, 2000). The ideal would be to bring in an outside facilitator, so I could become another participant.

At the International Association of Facilitators meeting in April 2000 I learned about an approach to collaborative problem-solving called Action Learning. At the end of the semester, I floated a proposal to begin the course with anAction Learning project on a case of interest to all the students, and then, against the background of that shared and messy experience, introduce texts and explicit frameworks. This proposal was seen positively by the students (see written comments), but one student was perceptive in asking what I would do if I "see a dysfunctional team or individuals being left behind?"

The topic I chose was "Extending the impact of CCT beyond its formal program of study. as begun by an outreach organization, "Thinking for Change." I had arranged some alums to help facilitate the initial Action Learning sessions, but unfortunately was not able to make time to train them beforehand. The group process could certainly have been smoother, yet the students in retrospect were impressed by the creativity and productivity of their groups' reports (see new exhibits). There was also some grumbling about my setting the problem, even though the groups took it in directions I didn't anticipate (they focused on the CCT program of study and suggested more internships and practical experience be built into it). In the future I plan to: a) precirculate the topic, framed in the spirit of Problem-Based Learning as an ill-defined problem that is open to their own definition of the problems to pursue; b) train the facilitators and provide guidelines to smoothe the process within groups.

During the spring 2001 course two other issues became clear that I hope will provide a clear and stable scaffolding for students in future offerings of the course:
i) I referred more explicitly to the Action Research cycle or spiral than before and elaborated on this as experiences emerged (see new exhibits). After recognizing that the Action Learning teams had focused on proposals, not on connecting with a constituency to implement them, we incorporated that into the framework. We also noted the importance of reflection and dialogue for defining the educational change desired or the relevant criteria for evaluating it.
ii) This led to my contrasting the exploratory, opening up character of the spiral with the focus provided by the Evaluation Clock (as rewritten by me to reduce the misreadings of the steps) in disciplining evaluation into measurable criteria.

Of the three plans from 9/99 listed above, I have continued to collect clippings, but the Participatory planning and Action Learning projects have taken the place of discussion of well developed cases and I have had almost no students in the area of science education. I have consulted with other GCOE faculty about the evaluation and research courses we offer, but the different programmatic needs means that, at least for now, the courses will follow their own separate paths. I still seek a suitable text for the course. Finally, my goal of more productive forms of course evaluation in GCOE was eclipsed by the work of the Evaluation task force in Fall 2000. To gain the feedback I need on my teaching and curricular innovations, I plan to continue to have students complete a second evaluation of my own design. This course, I expect, will continue to be a work in progress.

Contents pages for: <--Previous Course | this Course | All courses | Portfolio | the Next Course-->

Contents pages for: <--Previous Course | All courses | Portfolio | the Next Course-->

Synthesis of Theory and Practice

(CCT694/5, Fall 99, Sp 00)

(9/99 -- see appended 9/01 update)

Initial Goals
The Synthesis seminar provides a structure within which students get faculty and peer assistance and support in completing the written product of the synthesis project or thesis by the deadline. Because of the small class size and the progress students have already made over the summer, I am making time during class for them to step back and review their work in light of the "phases of research and engagement" that I introduce in the Practicum course (CCT698; see 2. above). My goal is to show that reflection and dialogue is valuable for clarification and more efficient writing, even when the product deadline looms.
I also want to wean students from relying on their faculty readers to do detailed copy-editing, a relationship between student and reader usually gets in the way of dialogue around the content and overall organization of the synthesis. I will provide encourage them to pay for assistance from some outside party, skilled in manuscript editing.
I am teaching this course this semester as an overload, and hope that my experience will stand me in good stead in the spring when more students are enrolled.

Challenges and Responses
The tension between product and process is evident at the outset. I want the students to revise what they have written during the summer and strengthen their exposition, but how far can I push this without their feeling I do not support their work? My initial response is to avoid detailed comments on the text, but to talk with them about what is distinctive in their projects and reflect back to them in an organized form what they say and what I discern. Eventually, however, I expect that their space for significant revision will disappear and I will work more on their terms.

Update
(9/01)

The tension mentioned above persisted during the Fall 99 semester, but the Spring semester worked well. Let me summarize the differences, which resulted in the contrasting student evaluations:

Fall 1999	Spring 2000
Previous instructor had mapped out a tight, product-oriented set of deadlines for submitting a thesis.	Syllabus gave more liberal target dates allowed for completion of a synthesis.
Students began semester with substantial evolving	Students began the semester with

investment in text already produced and insisting on their eye on graduation in time to get salary increases.*	projects, expecting but not finishing in the semester.
Students had not taken the Practicum with with me and me. They wanted me to show them how to fix themselves problems I saw in their text, as if these and were simply expository problems. writen	Students had taken the Practicum had a sense of clarifying for their direction, conceptualization, exposition through dialogue around comments.
Course taught as an overload. previous	Course taught with experience of semester under my belt.
All students finished.	Students did not all finish.
Pilot self-evaluation of product and process goals as way to document CCT program's translated into a effectiveness. Grade determined by instructor.	Students provided goals at start of semester. Self-evaluation grade.
I ended semester resolved to insist on students CCT698 completion before synthesis.	I ended semester more relaxed about not finishing during one semester.

* One student, who undertook her synthesis mostly at a distance, did not fit this description.

Nina Greenwald was the Synthesis instructor for 2000-1. I supported her by sharing my syllabus and experience, producing a revised guide for completion of a synthesis, arranging an alum to assist as editor / writing coach, and acting as an advisor or reader for some students' projects. Unfortunately, with my increased workload in spring 2001 I was not able to keep up with all the synthesis work submitted to me for comments.

Future Plans

This academic year Nina and I are co-teaching the synthesis both semesters (albeit as an overload for both of us in the fall) and hope to catch up so most students can graduate in a timely fashion. We also have to explore how to adjust in response to the elimination of course release for the CCT Program Director. (In the past this course release had allowed the Program Director to spend the time needed outside class working with syn / thesis students.) Because a project synthesizing theory and practice has been central to the CCT experience, we do not want to recommend to our CCT colleagues that the syn / thesis requirement be reduced to the capstone portfolio required in some other programs. Instead we plan to be strict about completion of the CCT698 report and synthesis proposal before enrolling in the synthesis seminar, and about students arranging editorial assistance.

Contents pages for: <--Previous Course | this Course | All courses | Portfolio | the Next Course-->

Contents pages for: <--Previous Course | All courses | Portfolio | the Next Course-->

Environment, Science, and Society

(Critical and Creative Thinking in Science and Technology, CCT640, Sp 01, 02)

(9/01)

Initial Goals
The goals for this course are described in the Course description and Objectives (see syllabus). It would be a course for environmental educators, formal or informal. Like CCT611 (see 4 above), it would operate on three levels:
The course material, activities, and teaching/learning interactions provides students an opportunity to learn new science and approaches to interpreting science, a set of models for their own teaching and educational work, and a basis for discussions and reflection about practices and philosophies of education.
Because the content level dominated in CCT611, I prepared activities that involved design of lesson plans and problem-based learning units and I would encourage curriculum course projects, not only research papers.
As a critical thinking course, it would also explore a number of "critical heuristics"‹propositions that place established facts, theories, and practices in tension with alternatives. In particular, it would address a tension between using simple themes, including the critical heuristics, to open up discussion and producing more complex accounts of the factors influencing environmental problems or the construction of scientific knowledge about the environment.

Challenges and Responses
The teacher-oriented changes from CCT611 were reasonably effective, but ironically the teachers in the course said they would have been happy to focus on stirring up their thinking and to leave lesson planning till later. At the same time, discomfort was expressed at various points about having so much opened up to question, especially, about the social influences on someone's science, without a firm framework or conclusion to hang onto. When students found out about my book manuscript and other writings, they expressed interest in reading a more complete exposition of my science-STS framework. I prepared some handouts, but

persisted in activities intended to lead them to formulate their own responses to two key tensions: between taking scientific knowledge (or critiques of science) literally and interpreting them in terms of social influences; and between simple themes and more complex accounts.

Another challenge was that students' proclivity for discussion often meant I had to leave out a planned activity. This was still the case, but less so, when I distributed specific activity guides. At the end of a long day‹for the students as well as for me‹it was difficult to be strict about staying on task and time. Students' interest in discussing their ideas about environment, science, and society meant they did not use their thought-pieces as much as I intended for weaving the course material into their own thinking. I used my comments to make connections, but since most of the students had not taken CCT courses before, revising and resubmitting did not come easily.

Future Plans

The experience in this course and ED610 in Spring '01 has led me to adjust three requirements in CCT611 and ED610 for Fall '01, which I plan to continue in CCT640: a) "thought-pieces" (which to many students connoted off-the-cuff thoughts) have become "mini-essays" and I will emphasize the need to refer to class material and reading; b) journaling and workbooks have become "a professional / personal development workbook"; and c) homework tasks will be given explicitly in the early weeks to stimulate active use of the workbooks.

I plan to continue activity-based classes around critical heuristics and encourage students to develop related activities of their own. I plan also to: a) provide summaries of the heuristics that emerge beyond those given in the syllabus; b) provide a reading on my larger framework at the outset as a way to scaffold the approach I use; and c) make available for those interested my publications related to teaching critical thinking about science and the manuscript of The Limits of Ecology. Perhaps the appointment of Hannah Sevian to teach secondary science education might eventually allow me to focus on the content level (science and its social interpretation) and make progress on the website and text described in the personal statement.

Finally, I plan to continue to promote this course among environmental science students‹half the Spring '01 students came from outside the GCOE‹and support proposals for an environmental studies M.Ed. track into which this course would fit.

Contents pages for: <--Previous Course | this Course | All courses | Portfolio | the Next Course-->

Contents pages for: <--Previous Course | All courses | Portfolio | the Next Course-->

Computers, Technology and Education

(ED610, Sp 01, F 01)

(9 / 01)

Initial Goals
Having been assigned the secondary education section of Ed610 at short notice, I built my syllabus on the plans I made after teaching CCT670 in 1998: making explicit at the outset the critical thinking aspect of the course; early classes hands on; starting with the WWW; required teacher-student conferences; etc (see 1.). Given that I was not experienced using computers in K-12 classrooms, I would also a) bring in guests who were enthusiastic and experienced in using pedagogically powerful software; and b) model the commitment and capacity for ongoing professional development, including learning from colleagues and students, I wished to engender in students‹in short, I would try out new things and learn on the job.

My other goals derived from a number of expectations: c) a diverse range of subject areas and technical competency would be represented, so I planned to illustrate principles and survey possibilities more than train them in specific software; d) the students could learn from peers when classes were in a computer lab and also outside class, so I invested in activities on learning communities, co-operative group-work, establishing an email list, and assigning homework (beyond assignments) to be done outside class sessions; e) the students would be experienced as teachers or have taken several courses in teacher ed. so they would be comfortable translating new ideas into lesson plans; f) there was lots of flux and hype around the power of new technology, so students would see the importance of keeping track of changes in technology that might feed into education and our lives more generally; and g) a majority of the teacher ed. students would (based on my CCT670 experience) come to appreciate the critical thinking emphasis I bring to the subject.

Challenges and Responses
This was a very challenging course to teach on two levels:
1) Technically, there was a lot to learn‹about using email lists, a course web portal, smart classroom, universal design software; and in arranging facilities for the guests, booking labs

and presentation rooms, etc. Not everything went smoothly‹from the sound having been turned off in one smart classroom after I did my practice run to viruses infecting many students' projects just before I uploaded them onto the website for the final showcase, I learned the hard way, namely, in front of students.

2) Pedagogically, there was also a lot to learn‹how to lead students into internet research on effective lessons using of computers; coax them over math phobias so they could create formulas for spreadsheets; and nudge them away from their individual terminals to help each other or to participate in small group discussions. I also had to rethink the goals in light of my expectations (outlined above) not all holding. The range of subject areas was indeed diverse, but, with prospective elementary teachers also enrolled, even more so than I had assumed. More importantly‹as I discussed in my personal statement (sect. II.E)‹ it was not easy to engage students in the range of teaching/learning interactions laid out in the syllabi. In particular, few revised significantly in response to comments and many did not seem comfortable with my expectation of self-constructed learning‹learning new ways to learn‹which requried practice out of class. (There was a strong preconception that this would be a lab course, with all the attendant connotations of most of the learning being hands on.) I responded thoughtfully, respectfully, and professionally to students' resistance and criticisms (see new exhibits); made adjustments where possible without inventing a new syllabus mid-stream; initiated class discussions on the challenges of teaching such courses (see new exhibits); and spent considerable time developing guidelines to engage current students if possible and provide a scaffolding for future courses.

At first my reworking of the course was directed at satisfying student interest in a hands on introduction to general-purpose browser, spreadsheet, and presentation software. I changed my mind, however, about the long-term educational value of this approach after I noticed two things: a) student fieldwork reports confirmed my impression that in actual classrooms computers and software fell into disuse unless there was a strong and clear pedagogical reason to use them; and b) most exponents of technology in education were general enthusiasts for using technology, but provided little guidance about specific situations in which specific software could be of significant pedagogical benefit. I produced a new syllabus for Fall '01 (with student input‹see comments in this binder and course design activity in the new exhibits) that attempts to ease future students into a sustainable approach to integrating computers in education through: a) more explicit scaffolding (see exhibits) and b) the requirement that they keep a Professional Development workbook in which they insert homework tasks they have completed. Indeed, after the first three classes of the semester, there is a noticeably higher level of student involvement in the class and attention to homework tasks.

Future Plans

I hope that I can sustain the students' involvement this fall and that they come appreciate my multi-stranded approach to this subject. However, I also plan to propose to the Teacher Ed. program that it reviews the role of this course in the secondary teacher ed. curriculum. I believe that the course should not be taken by students without first completing foundational curriculum design and pedagogy courses. Moreover, I do not think it should be presented as a lab course. Instead, students should be strongly advised to undertake technical training through the courses offered by Computer Services; this would allow the course to focus on the education side of computers in education. Finally‹especially while GCOE faculty members are building up their own technology skills‹the Program should, I would propose, try to retain the services of the adjuncts who have brought real life experience using computers in K-12

classrooms into the course in the past.

Contents pages for: <--Previous Course | this Course | All courses | Portfolio | the Next Course-->

Contents pages for: <--Previous Course | All courses | Portfolio | the Next Course-->

New Directions in Science Education

(CCT697, Sum 00)

(9/01)

Initial Goals
I organized and taught in this course for several reasons: a) to create visibility for my CCT emphasis on science in its social context and, through non-credit options, to draw non-students; b) to teach in my specialty science-STS area given that teaching required CCT courses meant I had not been able to during the previous year; c) to experiment with a course consisting of Friday-Saturday, 1-credit workshops so as to accommodate students and faculty who did not want to give up either their weeks or their weekends during the summer; and d) to fulfill unmet need in GCOE for secondary science education courses.

Apart from organizing the course, I would lead one of the two-day workshops on the topic Science in its Social Context, along the lines of CCT611 (see 4.) One goal I had was to stimulate participants to study or collaborate further with me.

Challenges and Responses
Many of the for-credit students turned out to be M.Ed. students seeking a science course to complete their degree, so I did not recruit them to further courses! The evaluations indicate that some of them wanted the workshop leaders to translate their approaches into the terms of science classrooms operating under the pressure of MCAS. However, others came to accept that stimulation was sufficient; it was up to them to do the translation.

In my workshop, which had a large number of additional non-credit participants, discussion was lively. I found, however, that energy flagged by the end of the second day and, even beforehand when analyzing the homework reading, I carried more weight than I preferred in keeping things going. Beside shortening the workshop or reverting to a standard weekly class format, the best response I can see is to draw the participants into a group project that they would be invested in finished. For example, I could use a problem-based learning (PBL) unit about new developments in human reproduction that I adapted from a case Steve Fifield introduced me to (see entry in Thinking for Change fieldbook on CCT website). Such a workshop would follow well after Nina Greenwald's on PBL.

Future Plans

Before I make the shift from a mini-course on science-in-society to PBL, the course needs to be formalized as a new course or the description of CCT640 altered so as to highlight its attention to new directions in science education. I was not able to prepare this proposal in time for last summer's catalogue and the course did not attract sufficient enrollment using the old description inserted by the publications department. I do not plan to organize the course next summer, preferring to see if the need for it is less now that I am teaching more science-STS seminars and Hannah Sevian has joined the GCOE faculty to teach in the area of secondary science education. In the meantime, I continue to seek opportunities to lead science-STS workshops (see sections I.B.3 and III.A of my personal statement) and am learning to lead PBL classes (see 12. below).

Contents pages for: <--Previous Course | this Course | All courses | Portfolio | the Next Course-->

Contents pages for: <--Previous Course | All courses | Portfolio | the Next Course-->

Critical and Creative Thinking in Practice

(CCT697, F 00)

(9 / 01)

Initial Goals
Like the non-credit CCT Forum in Fall 1999, this course would consist of weekly presentations and workshops given by current and former CCT students, faculty, and guest speakers related to their efforts putting critical and creative thinking into practice in schools, workplaces, and other settings. I initiated the CCT Forum to allow a) participants to experience, not only hear about, the range of approaches that fall under CCT; b) students to be introduced to the content of courses in future semesters; c) CCT alums, others in GCOE and the wider public to feel connected with CCT, and current CCT students to connect with them; and d) CCT students and alums to practice presentations and workshops before they give them elsewhere. The CCT in Practice sessions have been scheduled back-to-back with the required creative and critical thinking core courses especially to allow new or prospective CCT students to attend.

The goals of formalizing the sessions as a course were to: a) encourage new or prospective CCT students to participate in the full series of presentations and get a picture early on in their studies of the range of approaches that fall under CCT; b) over two semesters, in conjunction with credit for organizing and participating in the April CCT in Practice Open House day, constitute a 3 credit option; and c) provide institutional recognition for the work I had done voluntarily the previous year and would continue as an overload.

Challenges and Responses
Attendance of non-credit students and members of the public was good at the start of the semester, but, not surprisingly, declined to the formally enrolled students by the end of the semester. However, few new CCT students stayed after the creative thinking core course to attend and enrollment was small. With the elimination of course release for the CCT Program Director, I did not have time to continue the series in the spring or to submit a proposal to formalize this special topics course. (I did. however, organize another CCT in Practice Open House day of workshops in April.)

Future Plans

Until the resource squeeze in CCT eases, the CCT in Practice presentations and day of workshops will be modified into extended afternoon / evening sessions a few times per semester. This format began with a very successful Orientation / Community Gathering at the start of the fall 2001 semester. When the CCT faculty review the program of study in preparation for the AQUAD review, institutionalizing CCT in Practice will be considered, but most likely will not be made a required course for new students unless the number of electives is increased from three to four or five.

Contents pages for: <--Previous Course | this Course | All courses | Portfolio | the Next Course-->

Contents pages for: <--Previous Course | All courses | Portfolio | the Next Course-->

Critical and Creative Thinking in the Workplace

(CCT697, Sum 01)

(9 / 01)

Initial Goals
Once I began directing the program I became aware of previous attempts to expand CCT in the area of critical and creative thinking in the workplace. Responding to interest from a loyal CCT adjunct, I organized a Friday-Saturday, 1-credit workshop in summer 2000. Building on this and my own interest in reflective practice, I organized a suite of three courses through Continuing Education‹The Dialogue Process (CCT616), Constructivist Listening (winter), and CCT in the Workplace (summer) that could be taken on their own or as part of a version of the CCT Certificate with the theme, "Dialogue and Collaboration in Organizational Change." CCT in the Workplace would consist of three Friday-Saturday, 1-credit workshops, with options to take individual workshops on a credit or non-credit basis. I originally planned to lead the workshop on participatory planning, but, given my other commitments, was happy when Tom Flanagan agreed to lead a workshop on "Large Group Collaborative Design" in my place. My role became organizer, host, occasional participant, and grader of portfolios.

Challenges and Responses
This course proved very popular, drawing students from a variety of programs and leading a number of students to apply to or transfer into CCT. The Friday-Saturday format was widely appreciated.

The biggest challenge relevant to me if I teach a workshop on participatory planning in the future was dissatisfaction with the second workshop on Large Group Collaborative Design. Tom Flanagan and his co-instructor, Kevin Dye, decided not to teach their methods directly, but to have the group learn by experiencing them as participants in a Large Group Collaborative Design. They knew from experience that discussion of the process along the way detracts from participants carrying the process through to its culmination, and it is experience of having collaboratively created a plan / design that motivates people to learn and practice the required techniques of working in large groups. Participants this summer wanted more gratification along the way and more take-away tools to use.

Future Plans

A proposal to formalize this course is now being prepared. Once this is in place, I will consult with Tom and Kevin about who will teach the second workshop and how to improve its reception.

Contents pages for: <--Previous Course | this Course | All courses | Portfolio | the Next Course-->

Contents pages for: <--Previous Course | All courses | Portfolio

Making Sense of Numbers

(Seminar in Critical Thinking, CCT611, F 01)

(9 / 01)

Initial Goals
Early in the summer I changed the theme of my Fall '01 Critical Thinking seminar from Science in Society (see 4.) to Making Sense of Numbers for three reasons: a) there was a number of math. teachers among new or prospective CCT students, but no science teachers; b) CCT650, Math. Thinking Skills would not be offered in the fall; and c) experienced graduate students from this course might qualify as teachers for an equivalent undergraduate Quantitative Reasoning seminar in the Spring '02 and beyond.

Like CCT611 in Sp 99 and CCT640 (see 4. and 7. above), the course will operate on three levels, the first level in this case being "learn[ing] a variety of tools for quantitative reasoning and how to interpret their application to situations of social significance." My training and scientific work has involved much quantitative / mathematical work and many of the classes build on activities developed in other contexts. Nevertheless, the course is explicitly experimental and my goal is to model the ongoing pedagogical development I expect of the students. I particularly look forward to leading a three-week unit of full-blown Problem-Based Learning (drawing on Nina Greenwald's expertise) and coaching the students to compile their Personal / Professional Development workbooks (see comments on CCT640 earlier).

Challenges and Responses
The students are all new or prospective CCT students, so I have to get them comfortable with journaling; learning through activities, not lectures; my revise and resubmit system; and other CCT-style practices. The bigger challenge, however, has been adjusting to the turmoil and stress after the September 11 attacks. On the 12th. I introduced them to pairwise constructivist or supportive listening, but ten minutes of this was barely enough for me to focus on the rest of the class. The following week, I led a discussion on "What stops people asking why" as the fundamental question of critical thinking and then asked them to prepare on index cards their own critical thinking questions in this situation concerning numbers. I plan to continue to acknowledge in different ways that we cannot readily return to life / work as usual. Meanwhile, for this and other situations, we have to examine why the numbers we need are

difficult either to find, to make sense of, or to get attention paid to their implications.

Future Plans
n / a yet

Contents pages for: <--Previous Course | this Course | All courses | Portfolio

---

EXHIBITS
related to
Teaching and Advising

(9/01)

The exhibits have been selected to illustrate the sections discussed in Section III of my personal statement.
(Arranged in chronological order within each section. When no link is given, the exhibit is available in hard copy only.)

Wide Scope of My Teaching and its Active, Ongoing Development

- See Binder 4, Courses

The Philosophy of Teaching Critical Thinking I Brought to UMB

- Statement included with 4th year review portfolio

Teaching Critical Thinking about Science in its Social Context

- See Binder 7, Building a Basis for Interdisciplinary Science and Environmental Education

Leading Students from Critical Thinking to Taking Initiative

- From "dialogue around written work" to "taking initiative," Report on Teacher-Research during the Fall 1999 Center for Improvement of Teaching Faculty Seminar
- Course packet for Practicum: Processes of Research and Engagement (CCT698), Fall 2000 [previous students' work omitted]
- Revise and resubmit system as illustrated by student work and my comments in CCT698, Fall 2000
- "We know more than we are, at first, prepared to acknowledge: Critical thinking as journeying," work-in-progress about the role of listening, dialogue, intra-personal reflection, and the journey metaphor in fostering critical thinking.
- Reports from Action Learning Project in Evaluation of Educational Change (CCT693), Spring 2000
- Chart of Action Research Spiral developed during CCT693, Spring 2000

Learning from Difficult Courses in a Thoughtful, Respectful, and Professional Manner

- Thoughtful and respectful responses in a difficult course as illustrated by student work and my comments in ED610, Spring 2001
- Instructions and summary of reports from small group work on revising the Secondary Ed. Computers, Tech & Ed. syllabus

Learning from Educators beyond CCT

- "Alternating between teacher and facilitator," summary of workshop presented to the International Association of Facilitators, Toronto, Canada, April 27 - 30 (www.iaf-world.org/iaf2000/Taylor.PDF)

Promoting Collegial Interaction Around Innovation in Teaching

- See Binder 7, Building a Basis for Interdisciplinary Science and Environmental Education, and Developing CCT in New Directions

Personal Statement:
Furthering Critical Thinking, especially about Environment, Science & Society[*]

Peter J. Taylor
Program in Critical & Creative Thinking
Graduate College of Education, University of Massachusetts, Boston
September 1999

Preamble

I joined the Critical and Creative Thinking (CCT) Program and the Graduate College of Education (GCOE) in the fall of 1998 and am enjoying new challenges in teaching prospective K-12 teachers, experienced teachers, and other working, mature-age students.

My prior training, teaching, and research experience has been at intersection of the life/environmental sciences and social studies of science and technology (STS). My research career started in Australia in ecology and agriculture, areas I was drawn to by my environmental and social activism. I moved outwards into studies that incorporate socially-generated effects in the agriculture and the environment, and into STS. After completing a doctorate in ecology in 1985 (with a minor focus in STS), I have combined scientific investigations with interpretive inquiries from the different disciplines that make up STS.[1]

This dual background has allowed me to examine specifically how scientists as practicing social and intellectual agents build diverse aspects of their "sociality" into the particular ways they know the world and practice their science. The framework I call "heterogeneous construction" highlights the diverse resources scientists harness-from funding opportunities to metaphors, from status hierarchies in their field to available sources of data.[2] Accordingly, whether in my science-STS classes or in research workshops with practicing scientists, the participants learn to tease out the diverse linguistic, intellectual, and practical resources harnessed in scientific work.[3] My goal is that they bring such understanding to bear on their own projects as learners, researchers, and social agents--that they become reflective practitioners.

As I endeavored to stimulate life and environmental students and scientists to draw on STS perspectives, I saw that critical thinking and critical pedagogy were central to my intellectual and professional project.[4] I had to encourage students and scientists to contrast the paths taken by science, society, learning, and people's lives with other paths that might be taken, and to foster their acting upon the insights gained. I now have the opportunity in CCT and GCOE to extend this work in two directions: i) from teaching college students to working with educators who teach from K through college levels, and ii) from workshops with already reflective researchers to a wider group of scientists and citizens, especially those involved in debates about the social impact of science and in community-based research. (Now also that I have learned more about the tradition of critical and creative thinking, it is clear that my emphasis on using critical thinking and pedagogy to change one's practice spans both aspects of CCT's mission.) Bringing critical analysis of science to bear on the practice and application of science has not been well developed or supported institutionally, and so my contributions to this project necessarily span the three areas of research and writing, teaching and advising, and service and institutional development.[5] New collaborations, programs, and other activities, new directions for existing programs, and collegial interactions across disciplines are needed. In this light, I set myself the goals for 1998-99 of bringing my work into the setting of the Program in Critical and Creative Thinking, the Graduate College of Education, and U. Mass. Boston. This would require learning about and responding to the culture of CCT and the field of public education more generally, and starting to build space

and support for the directions I have been describing.

1. RESEARCH AND WRITING

If critical thinking and critical pedagogy have become central to my intellectual and professional project, the challenge now in my research and writing is to make that explicit for audiences in education, and to make that compelling for audiences in the life and environmental sciences and STS.

I am currently working on the last chapter of The Limits of Ecology, a book under contract with the University of Chicago Press. (Working on the manuscript is the focus of my writing for this academic year.) This book develops the framework of heterogeneous construction and explores its implications through conceptual, historical, and sociological reconstructions of selected episodes in ecology and environmental studies.[6] The link between critical thinking/pedagogy and the book's concerns is becoming more explicit than I had originally envisioned, which is true in varying degrees for the related essays that I completed during the year.[7] The conceptual/ pedagogical/ practical issue holding my attention at the moment is as follows:

When science is analyzed as heterogeneous construction, one has to address a large range of relevant social agents, diversity of resources they mobilize, and possible points of engagement and reconstruction. In thinking about angles from which to encourage others to deal with this complexity, I have to recognize that simple themes, such as "Population growth will lead to environmental degradation," are easier to communicate to a general audience than particular reconstructions of the complexity in environmental situations or in the social context of researchers. In that sense, such themes appear to provide the bases for effective social mobilization--whether at the level of global environmental politics or, more modestly, at the level of teaching students and influencing colleagues. Yet, the logic of my book's development implies that simpler, more memorable and adaptable, accounts are only *apparently* simple. Their impact and importance depends on how they are linked to webs of other resources by scientists and other agents negotiating their contributions to changing knowledge, society, and ecology.

My pedagogical and expository response is to present situations or scenarios that are readily communicated and, at the same time, introduce "critical heuristics" that always point to the complexity temporarily backgrounded in the attempt to communicate to others. For example, I often run a classroom simulation involving population growth in two islands--one with equal distribution of resources; the other with three unequal social classes. The critical heuristic that emerges is to consider how the analysis of causes and their implications changes if equal units are replaced by unequal units, differentiating as a result on on-going social, political, and economic dynamics.[8] By introducing such critical heuristics, I aim to keep the tension between the logic of complexification and the pragmatics of apparent simplification active and make it productive. This endeavor is most fully realized to date in the recent essay, "What can agents do?"[9] and in new classes I introduced to the core Critical Thinking course (CCT601) this spring.[10]

Through teaching courses examining science in its social context I have generated extensive notes on almost thirty cases, which cover selected historical and contemporary texts and episodes in the life and environmental sciences, that introduce and illustrate a range of critical heuristics (a.k.a., "angles of illumination").[11] After completion of The Limits of Ecology I plan to produce a text and a web-site of associated pedagogical material to promote critical thinking about the reciprocal relationships between developments in the life sciences and changes in society. I intend the text/website combination both to reach

a wider biologist and STS readership and to contribute to bringing STS into science education and science into liberal arts education. The cases explore different connections between the science and four strands of social life--scientists' use of language; their social/historical location; their political and economic interests; and their views of causality and responsibility--and thereby break down the barriers between the natural sciences, the social sciences, and the humanities (see "Reciprocal animation" in section 2).[12]

I moved forward a little this last year on this project by preparing a proposal to the UMass Boston Professional Development Support (PDS) competition to revise an NSF proposal, and by delivering presentations at conferences, workshops, and the Changing Life working group on teaching critical thinking about the life and environmental sciences.[13] The PDS proposal was favorably reviewed but not funded, yet I still plan to revise and resubmit early in 2000 the NSF proposal, which concerns the intellectual history, current concerns, and reception of the fields of "gestational programming" and "life events and difficulties." These two cases--the last ones I plan to add to the text--allow me to bring more attention to the complexities of the concept "environment," and to enrich discussion in this Age of DNA about the environment's contribution to the development of behavioral and medical conditions over any individual's lifetime.

In addition to the text/website, it is clear that, now I am in a College of Education, I need to develop a program of research on dissemination and implementation of my framework for critical thinking about the life and environmental sciences. The research would center around the question: To what extent and under what conditions does placing developments in science and technology in their social context lead to deeper, more complex understanding and more active inquiry in college science education, high school education, and citizen involvement in scientific debates? One preliminary step is to connect with teachers willing to bring STS into their science and environmental curricula. With this goal among others, I convened this spring a monthly working group, Changing Life, on fostering critical thinking about the life and environmental sciences. With a seed grant from STEMTEC (Science, Technology, Engineering, Mathematics Teacher Education Collaborative) I also organized a one day practitioners' workshop on this topic;[14] a more intensive weekend workshop for college faculty and graduate students will follow in the fall or spring. If I am successful in finding teacher collaborators, I plan to seek funding for systematic research from, say the Spencer Foundation.[15] Another preparatory step is to read more widely and systematically in the relevant educational research literature. In this spirit, I volunteered to compile a draft syllabus/ annotated bibliography for the Critical Issues in Math. and Science Education course in the proposed M. Ed. track in Math. and Science Ed.

2. TEACHING AND ADVISING

My courses at U. Mass. include two in my specialty area of science in its social context ("science-STS") (one of these I have not yet taught), another that combined science-STS with computers in education, and four required CCT courses for students beyond my speciality area. Reviews and evaluations of each of the courses are contained in the Portfolio. What follows are some general remarks on my experience and plans as a teacher and advisor, which end by referring to the goal of "on-going development of pedagogy" and the exhibits in the Portfolio chosen to illustrate that goal.

Before coming to U. Mass. Boston, the key opportunity I had to develop as a teacher and to shape new models of teaching came through developing new courses and teaching methods appropriate to Cornell University's unique Biology and Society major and the STS Program/Department (1990-96).[16] This work

took place, moreover, in the context of increasing emphasis on teaching and advising at research universities, which motivated my contributions to new models of documentation and evaluation of teaching,[17] and to formal and informal collegial interaction around teaching, including a peer observation "teaching co-op." Academics need, I have long believed, the same level of sustained collegial give-and-take, collaboration, critique, and mentorship that we value around research and writing. The Fall 1999 faculty seminar of the Center for the Improvement of Teaching (CIT) on "Becoming a Teacher-Researcher," in which I am participating, promises to provide more of such interaction.[18]

My own learning as a teacher over the last five or so years, representing a more self-conscious constructivism in my educational philosophy, has focused on writing through the curriculum and promoting student-teacher dialogue around written work,[19] attention to learning and writing preferences,[20] developing an STS-style of critical thinking about science[21] (including critical heuristics[22] and diagrams and maps of more complex heterogeneous construction[23]), and designing opportunities for small group, co-operative, experiential, and problem- or project-based learning.[24] The ideas and tools I bring to facilitating participation in groups and workshops have also been expanded through connections to Re-evaluation Counselling,[25] and, more recently, the International Society for Exploring Teaching Alternatives,[26] the Institute for Cultural Affairs,[27] the school of Sense-Making that builds on the work of Prof. Brenda Dervin of the Department of Communication at Ohio State,[28] and the BioQuest Curriculum Consortium.[29]

Having joined the GCOE, I am taking up the challenge, as described earlier, of showing that K-12 science education can be enlivened and enriched by placing developments in science and technology in their social context.[30] I built my spring seminar on "Science in society" (CCT611) and to some extent in my fall course, "Thinking, Learning, and Computers" (CCT670), on three complementary features of my approach to teaching science and STS together, which are closely allied to themes of my research and writing:[31]

Reciprocal animation: Close examination of conceptual developments within the sciences can lead to questions about the social influences shaping scientists' work or its application, which, in turn, can lead to new questions and awareness of alternative approaches in those sciences. For example, although developments in computers are often promoted in terms of social or educational progress, historical and social analysis reveals the central role of military and, more recently, corporate objectives in determining which directions "progress" takes; [32]

Critical thinking in the following sense: Theories and practices that have been accepted or taken for granted can be better understood by placing them in tension with what else could be, or could have been, e.g., contrasting dominant models of global environmental change with those that emphasize the political and economic dynamics among unequal social agents;[33] and

Heterogeneous construction: Diverse practical considerations, not just their conceptual frameworks, shape people's knowledge-making, including their ideas about educational and social change.[34]

In CCT611 and CCT670 I wanted to extend my previous science-STS courses so that CCT and GCOE students would address the course material not only as an opportunity to learn the subjects themselves, but also as providing pedagogical models for their own future teaching, and as a basis for discussions about educational practice and philosophy. The first level, however, still dominated in CCT611 and somewhat in CCT670. In future science-STS courses I will keep working to boost the other two levels, for example, by preparing handouts so class activities can be readily adapted into lesson plans, and encouraging students to undertake lesson plans, not only research papers, for their course projects.[35]

Taking up this last point, an equally significant challenge in my CCT/GCOE experience as a teacher and advisor has been adapting my teaching to reach prospective K-12 teachers in M. Ed. programs and the diverse array of experienced teachers, and other working, mature-age students in the CCT Program. Some of what I learned in my first semester was reflected in the syllabi for the second semester courses, especially what I learned in the not-so-accurately named "Practicum" (CCT698)--in reality a course on "processes of research and engagement" (which is its new subtitle). Teaching teachers "Issues in Educational Evaluation" (CCT685) in the spring and co-teaching the large core course on Critical Thinking (CCT601)--both new kinds of courses for me--gave me further insight into the range of CCT and GCOE students.[36] I came to see that my model was "developmental," aiming not for a given final standard of work, but to guide and support each student to develop or improve as much as they can in their current, usually overburdened, circumstances.

A centerpiece of this developmental approach is what I have come to call "dialogue around written work." For each class I require a journal and set a variety of written assignments, including steps towards a final project report.[37] I make most of my comments not in the margins, but on a cover page in which I attempt to show students their voice has been heard, to reflect back to them where they were taking me, before making suggestions for how to clarify and extend the impact on readers of what was written. Although the appreciations section of my comments tends to be shorter than my suggestions--I still get to the "but" quickly--student evaluations acknowledge the feedback they are getting.[38] I ask students to revise and resubmit work as long as I judge that the interaction can still yield significant learning, which departs from most students' expectations of "produce a product one time only and receive a grade." To keep the focus on the individual's development, the rubric for the course grade does not involve my awarding grades until the final projects for the semester. Responding to students' misunderstanding of or resistance to this unfamiliar system has led to the streamlined set of requirements and grading rubric presented in my current syllabi,[39]and to the "Notes on Teaching/Learning Interactions" distributed as part of a course packet at the start of the semester.

Of course, articulating the desired teaching/learning interactions and including them in a course packet only takes one so far. The gap between the actual teaching-learning interactions and my ideals, in particular with respect to dialogue around written work, is what I want to be illuminated by peer observation and reflection in the Fall 1999 CIT seminar.[40] During the last academic year, I saw the need for more time to talk with and listen to students.[41] Given students' work schedules, I have to make the the time immediately before and after classes free of other tasks, such as last minute preparation for class. I also have to make more space and take more risks to address "difficult" students, those who want to proceed as they always have, interpret my developmental approach and the "revise and resubmit" system as an affront to their maturity and independence, avoid dialogue around their mis/understandings of my expectations, and miss out on the learning that takes place through dialogue and when we confront our resistances to truly sharing our work with others.

One consequence of the developmental approach is that students often characterize the early stages of my courses, including the early assignments as "ambiguous."[42] In response to specific questions I do work to clarify and streamline my instructions, and I think about whether re-ordering classes or redesigning activities would take students more gradually from the familiar to the new. Yet, I have learned that the root issue is generally one of students' confidence in their own thinking. If I patiently encourage them to reflect in their journals, submit thought-pieces, and revise in response to comments, and so on, they usually weave together

the strands and end up with a stronger sense of making the course material their own. Evidence for this can be seen, for example, when at the end of a "historical scan"[43] of "Thinking, Learning, and Computers," students divided the course into two phases and suggested the names "Big Bang" (for all the new issues that were introduced) and "Realizations" (for ways that the issues came together for them). Similarly, co-teaching "Critical Thinking" the next semester, students persistently asked us what "exactly" we wanted in the end-of-semester manifestos. The stated goal of the assignment was for them "to finish the semester with a synthesis of elements from the course selected and organized so as to inspire and inform [their] efforts in extending critical thinking beyond the course." Because this was a new assignment, we had no examples from previous courses, and so the main response we could make to their anxiety was to ask them to wait and see what emerged for them by the end of the semester. This advice paid off. The resulting manifestos were more powerful and personally reflective than even we had hoped, especially when viewed against several students' claims during the course not to be the critical thinking type.[44]

Despite successes, I see my CCT and GCOE teaching as very much a "work in progress." Indeed, I sometimes make a virtue of this, modelling what I expect of my students--to experiment, take risks, adjust plans, and through experience and reflection build up a set of tools that work for oneself. Of course, this does not play well to all adult learners, especially when they are pragmatic about what they can and need to accomplish in their limited time left after work and their other responsibilities. Even CCT students do not all embrace the ideal of becoming reflective practitioners, and, if I am to serve non-CCT students as well, I need to keep addressing the tension between the CCT ideal and losing students who come to class, or to the course as a whole, un(der)prepared to engage for themselves and most comfortable when the important lessons are didactically presented. The best evidence that I will continue to make progress on this front is the variety of ways, illustrated in the Portfolio, that I evaluate and reflect on my own practice, especially with respect to the goal of "on-going development of pedagogy."[45]

3. SERVICE AND INSTITUTIONAL DEVELOPMENT

In this section I review the initiatives I have taken and articulate some of the challenges I see in sustaining the CCT Program, promoting Critical and Creative Thinking and developing it in new directions, and establishing a place for the Program in the GCOE. I give special attention to my interest in strengthening the Science-in-Society strand in Science Education.

3.1 Critical and Creative Thinking Program

Traditionally, CCT courses and workshops have covered "psychological studies of the scope, limits, and techniques of critical and creative thought, information processing, and conceptual learning in children and young adults; philosophical studies of techniques in reasoning, argument, logical thinking, valuing, and judging; and work with cognitive structures and metacognitive techniques for stimulating creativity and critical thought." At the same time, social justice concerns have motivated the educational and social change work of many CCT students and faculty. I am building on this basis in developing another strand in CCT focusing on examining science in society in order to foster critical and creative thinking in science. I have been publicizing this direction for CCT and doing outreach the program more generally by various means: flyers at conferences, postings on email networks and announcements in journals, reviving the CCT web-site,[46]convening the "Changing Life" working group fostering critical thinking about the life and environmental sciences,[47] and, most importantly, a one day summer workshop, "Science in Society,

Society in Science."[48] It is too early to see yield from this outreach in students joining the CCT Program or enrolling in relevant CCT courses, and I plan to continue promoting CCT and its Science in Society strand. Over the course of the year I became aware how important outreach is in general for the CCT Program because there is no standard conduit of students. However, before having much time and energy spare for outreach, it has been necessary to share the administrative burden with the Director, Delores Gallo--the only other GCOE faculty member in the Program--and maintain the engagement of the crucial CCT faculty from outside GCOE. To this end, I reviewed applications and took on a growing number of advisees, prepared guidelines for students planning CCT course sequences, convened monthly faculty meetings in the spring that balanced business with discussions of each other's work, initiated discussion to review the required courses, re-established the CCT web-site, and completed the long-awaited CCT student handbook. Although Prof. Gallo's taking medical leave increases the load on me as an advisor, some of these initiatives will result in a streamlined and reduced advising load. Moreover, Prof. Gallo's efforts in recent years have cleared the backlog of students needing to complete their theses and synthesis projects. With Prof. Gallo not available to advise and support CCT students, I am working as acting Director to build more "horizontal" exchanges and support within the community of CCT students and alums. A regular (weekly?) program of events to help people meet and learn from each other is being planned for the evening before the Creative Thinking and Critical Thinking core courses are offered. In the same spirit, we are compiling a directory of current and former CCT students, which will include information about their interests and experience.[49]

I look forward to continuing such outreach, but these efforts would be enhanced by a clearer sense of the vision GCOE has for the Program now it is formally in the College, and by establishing a plan for the level of course offerings supported by GCOE and by CAS. To stimulate CCT's contribution to this clarification and planning, I prepared a set of "talking points" at the end of last semester and an analysis of long-term CCT course offerings for discussion during the Program's fall faculty meetings. The transitional and hybrid character of the CCT Program--formally in GCOE, but with most of its history and all but two of its faculty in CAS--also means that appropriate criteria for review, composition of review committee, and pool of potential outside reviewers have to be established. Given that I am the first person in CCT to whom this issue is relevant, I trust that this 4th year review will be taken as an opportunity to discuss, clarify and address these matters. Moreover, the nature of my interdisciplinarity means that it is not straightforward to define a community of peers for my work. In short, some of the best support I could get as a junior colleague, needing to decide what work to undertake and how to prepare the strongest tenure dossier, would be for explicit attention to be given to the particularities of my position.

3.2 GCOE initiatives, especially in Science Education

Of course, faculty within the College should serve students outside their home Program. In preparing and revising my science-STS courses, I have consulted with the Teacher Ed. Director and one of the Computer Ed. adjuncts, but would like to have more interaction with faculty, including adjuncts, in order to learn how best to meet the needs of both M.Ed. and CCT students in these courses. On another front, I became aware that many evaluation and research methods courses are being offered in different GCOE programs. I initiated syllabus sharing in the spring and plan to convene meetings of the relevant faculty this fall to share our experiences and explore co-ordination or rationalization of our efforts.[50] I would be happy if more non-CCT students took the two research courses I teach (CCT685 and CCT698). In this spirit, I designed my version of "Issues in Educational Evaluation" (CCT685) so that it would flexible enough to address the

concerns of a range of students who might take the planned M.Ed. track in math. and science education. With support from Profs. Lukas and Clark, co-chairs of the committee to establish the Math./Sci. Ed. track, I am beginning to fashion a series of cases concerning Math. and Sci. Ed. for a case- or problem-based learning for this course.

As mentioned above, I also contributing to the development of a core course in the Math./Sci. Ed. track on Critical Issues in Math. and Science Education. When CCT and the science-STS strand within it is on a firmer footing--which would not be before my tenure review--I would like to teach such a course every other year in place of one of two science-STS courses. Although I hope to participate actively in the Math./Sci. Ed. track, I believe another faculty member, more experienced in and committed to standard Science Education, should be found to direct the Program. To redirect my work in that direction would not be the best use of my experience and passions around science-STS teaching. Splitting my energies between the CCT program and Math./Sci. Ed. track would do justice to neither.

The issue of GCOE's contribution to Science Education is an important one, not the least because of the looming shortfall in qualified Science teachers in Massachusetts. During the year and especially through organizing the summer workhop I became acquainted with the range of funded centers and initiatives in Science Education in the State. The College is not yet in a position to compete for funds with the more established programs, but collaboration with CAS may change this.[51] There is, however, a distinctive niche for contributions in the science-STS area. As Steve Fifield remarked in his evaluation of the summer CCT workshop: "The standards movement has a tendency to be interpreted as a push toward "the basics" (i.e., decontextualized facts and concepts), but it is important to make clear that the study of science in social context is a component of national reforms and most state standards."[52] Indeed, "Science, Technology and Human Affairs" is one of the four dimensions of the Massachusetts Curriculum Frameworks for Science. Unfortunately, the MCAS student tests discount that dimension. Nevertheless, I believe it is important enough to pursue, to identify allies and support teachers in "their attempts to broaden the meaning of science education."[53]

3.3 Initiatives outside U. Mass. Boston

As mentioned in the preamble, the idea that critical analysis of science can influence its practice and application is not well developed or supported institutionally, and so new collaborations, programs, and other activities--or new directions for existing programs--are needed. My work has involved many collaborations across disciplinary, institutional, and national boundaries.[54]

The most significant venue for me outside my formal appointments has been in the International Society for History, Philosophy and Social Studies of Biology (ISHPSSB). In its biennial summer meetings the ISHPSSB brings together scholars from diverse disciplines, including the life sciences and history, philosophy and social studies of science. I served on the Executive from 1993-99 as President-elect, President, and then past-President. My earlier contributions, however, on the program committee (1987-89) and as program organizer (1989-91), were equally significant. It was during this period that the society was being formalized, and I worked hard to ensure that institutionalization did not undermine the tradition of innovative, inter- and trans- disciplinary sessions and discussions. I have personally organized sets of sessions at almost all of the ISHPSSB meetings, many of which have led to special editions of journals and one book.[55]

I also served on the council of the Section on Science, Knowledge and Technology of the American

Sociological Association (1993-96), and was nominated in 1994 as a candidate for the council of the Society for Social Studies of Science (4S). My major contribution to both these groups has been organizing conference sessions that explore new or underdeveloped connections, e.g., between social studies of science and social theory. In recognition of my ability to make transdisciplinary connections, I have been invited to give commentaries in areas ranging from economics and STS to methodology in studies of communication.[56]

The main focus, however, of my current and planned service is in the area of education. I initiated and continue to chair the ISHPSSB Committee on Education, which aims to contribute to and link ISHPSSB members to current initiatives concerning the teaching of science in its social context.[57] The "Changing Life" working group is a local initiative in that direction. I have been asked to plan a future BioQuest curriculum development workshop on this theme in 2002, and am collaborating with Prof. Fifield from U. Delaware to organize a related workshop for college faculty in 2000 or 2001. In November I served as a consultant on the plans for a new interdisciplinary environmental studies doctoral program at the National University in Mexico (UNAM) and next month I will be consulting with Jin Sato from from the University of Tokyo who is in charge of initiating a similar program. I look forward to continuing to collaborate in boundary-crossing initiatives.

Practitioner's Portfolio

Peter J. Taylor
Program in Critical & Creative Thinking
Graduate College of Education
University of Massachusetts, Boston
September 1999

Every process in an educational institution can be a teaching/learning interaction, an opportunity for all parties both to teach and to learn from each other. In this spirit, I prepared this Fourth Year Report not only to provide the material to be used for the formal report to the College and University, but also to stimulate faculty members in the Critical & Creative Thinking Program (CCT) and Graduate College of Education (GCOE) to learn how better to foster my work, which includes responding in ways from which I can best learn. To meet both the formal and teaching/learning goals, the written form I have chosen for the report is a Practitioner's Portfolio. This consists of a personal statement, a review of my courses, and a set of exhibits. I welcome dialogue around the different components of the Portfolio to help readers appreciate work in areas or directions unfamilar to them, and to facilitate clarification and revision of my CCT and GCOE colleagues' various assessments, goals, and expectations, and of my own.
Submitting a Portfolio also corresponds to my view that formal reviews should attend to process as well as product. That is, for reviewers to be confident in continued effectiveness of a colleague, they should have evidence of the faculty member's on-going process of assessment and development of research, teaching, and responding to institutional challenges, and of cross-fertilization between those three aspects of a scholar's work.

Table of Contents

---

4. CCT611, Science in Society [Seminar in Critical Thinking]
5. CCT685, Issues in Educational Evaluation
6. CCT695, Synthesis seminar
7. CCT645, Environment, Science, and Society [Seminar in Scientific Thinking]

II. EXHIBITS

These have been selected to illustrate important characteristics, themes, and products of my work. Given my immediate audience in CCT and GCOE, these are organized around four overall pedagogical goals introduced in the statement of teaching philosophy that leads off the exhibits. Each section and each exhibit is introduced in a cover page.

Teaching Philosophy: Fostering Critical Thinking about Environment, Science, and Society

1. Reciprocal animation
- **A: Model courses**
- **B: Publications resulting from linking my scholarship and teaching**
- **C. Conceptual exploration and theoretical innovation**
- **D. Case studies**
- **E. Institutional initiatives**

2. Critical thinking
- **A: Writing for learning and reflection**
- **B: Making comments to stimulate rethinking and revision**
- **C: Exposing the constructedness of teaching and learning**
- **D: Teaching/learning as a joint dynamic**
- **E: Empowerment to act upon critical thinking**
- **F: Advising towards lifelong learning**
- **G: Facilitating trans-disciplinary exploration**

3. On-going development of pedagogy
- **A: Developing a large range of CCT courses**
- **B: Experimenting to develop STS and CCT pedagogy**
- **C. On-going development of courses**
- **D: Varieties of course evaluation**
- **E: Promotion of teacher-teacher interaction**

4. Heterogeneous construction as a model of agency

ATTACHMENTS

1. Curriculum Vitae
2. Annual Faculty Review, 1998-99 [not included on web site]
3. P/reprints of articles prepared or published since 1998, plus a selection of previous publications.[see C.V.]

EXHIBITS

(9/99) Some links not implemented
These exhibits have been selected to illustrate important characteristics, themes, and products of my work. Given my immediate audience in CCT and GCOE, these are organized around four overall pedagogical goals and related points introduced in a statement of teaching philosophy that leads off the exhibits. Each section and each exhibit is introduced in a cover page.

Fostering Critical Thinking about Environment, Science, and Society

Teaching Philosophy

1. Reciprocal animation

I promote strong two-way interaction between the sciences and interpretations from STS disciplines. The ways I do this are demonstrated in five exhibits:
A: Model Science-in-society courses, which break down the barriers among the natural sciences, social sciences, and the humanities; and between the sciences and STS.
B: Publications resulting from linking my scholarship and teaching.
C. Conceptual exploration and theoretical innovation.
D. Case studies using social contextualization of science to enliven science education and wider social discussion about science.
E. Institutional initiatives.

2. Critical thinking

I encourage students to contrast the paths taken by science, society, learning, and people's lives with other paths that might be taken, and to base actions upon the insights gained. To promote critical thinking my teaching and advising emphasizes:
A: Writing for learning, in contrast with writing to show what a student has learned.
B: Making comments on writing in ways that stimulate rethinking and revision.
C: Exposing the constructedness of teaching and learning; acknowledging the variety of ways people develop questions and come to know what they know.
D: Teaching/learning as a joint dynamic; both learning and teaching benefit from teachers and students viewing the class from both the teacher's side and the students'.
E: Empowerment to act upon critical thinking, building students' confidence to go beyond simply adopting a critical position.
F: Advising towards lifelong learning
G: Facilitating trans-disciplinary exploration

3. On-going development of pedagogy.

My commitment to developing STS teaching over the long term, and CCT teaching in the last year, has led me to experiment, innovate and develop better ways to learn from teaching about teaching and learning. This is evident in my:
A: Developing a large range of CCT courses.
B: Experimenting to develop pedagogical approaches specifically tuned to STS and CCT and their open-ended state as fields.
C. On-going development of courses.
D: Varieties of course evaluation, integrated into the teaching/learning process.
E: Promotion of teacher-teacher interaction.

4. Heterogeneous construction as a model of agency

Table of Contents for: Exhibits | | Next-->

EXHIBITS

Teaching Philosophy

This statement of teaching philosophy dates from 1995. The only significant revision since then has been to make explicit a fourth goal, namely, to "introduce heterogeneous construction as a model of agency." Rather than formulate a new statement after only one year working in a College of Education, I decided to reflect on the transition by taking stock of the ways that my current efforts fitted within or departed from the 1995 statement.

<--Previous | | Table of Contents for: Exhibits | | Next-->

---

1. Reciprocal animation

I promote strong two-way interaction between the sciences and interpretations from STS disciplines. The ways I do this are described in the personal statement and the statement of teaching philosophy and demonstrated in the five exhibits that follow.

A: **Model Science-in-society courses**, which break down the barriers among the natural sciences, social sciences, and the humanities; and between the sciences and STS.

Extracts from the syllabus for CCT611, "Seminar in Critical Thinking: Science in Society"--

Course description, overview, and schedule of classes and activities. The full syllabus is included in section I.

B: Publications resulting from my **linking scholarship and teaching**.

i) My essay, "Natural selection: A heavy hand in biological and social thought" (1998; see attached p/reprints) originated from teaching of evolution as a graduate student. For several years, given that my research focus is in Environmental Studies and STS, the manuscript emerged only during my teaching of Biology and Society (see exhibit 1.B, classes 5 and 9). When preparing a more technical critique of natural selection theory for a Festschrift to Richard Lewontin, I revised "Heavy hand" and submitted it in a journal, Science as Culture, intended for a wider STS readership.

ii) My essay "Critical tensions and non-standard lessons from the 'tragedy of the commons'" (forthcoming) begins as follows:

C. **Conceptual exploration and theoretical innovation**

This exhibit consists of the table of contents and first half of the introduction to The Limits of Ecology, preceded by an excerpt from an earlier draft--which may find its way back in--that amplifies the role I give to conceptual exploration.

D. **Case studies** using social contextualization of science to enliven science education and wider social discussion about science.

Before I knew I was taking up a position at U. Mass. Boston, I prepared a proposal to complete a book of case studies "promot[ing] critical thinking about the reciprocal relationships between developments in the life sciences and changes in society." Exhibit i) is an attachment to the proposal, listing the cases already developed through my Biology and Society teaching. I also prepared an NSF proposal to do further research into one of those cases and research on an additional case. This research is described in the exhibit ii), my proposal to the U. Mass. Professional Development Support Competition to revise and resubmit the NSF proposal.

E. **Institutional initiatives**

The Committee on Education of the International Society for History, Philosophy and Social Studies of Biology (ISHPSSB), which I chair, aims to contribute to and link ISHPSSB members to current initiatives concerning the teaching of science in its social context. Exhibit i) is the initial version of the Educational WebSite.

I organized a one-day summer workshop, "Science in society, society in science," with the goal of showing how "placing developments in science and technology in their social context can enliven and enrich science education, science popularization, and citizen activism." Exhibits ii)-iv) are the publicity brochure, a post-workshop report in the form of a website, and an evaluation of the workshop written by Prof. S. Fifield of the University of Delaware.

I also convened, "Changing Life," a working group of teachers and students in the Boston area with interests in teaching critical thinking about the life and environmental sciences. For me, this includes teaching science in its social context. Exhibit v) is the flyer for the group.

<--Previous | | Table of Contents for: Exhibits | | Next-->

2. Critical thinking

I encourage students to contrast the paths taken by science and society, and by people's lives and learning, with other paths that might be taken, and to base actions upon the insights gained. To promote critical thinking my teaching and advising emphasizes the features described in the seven sections that follow.

A: Writing for learning, in contrast with writing to show what a student has learned.

In all my courses, written work is assigned to be submitted every week or every other week (see also exhibit 2B). Journals are required, which, together with in-class writing, help focus students' thoughts and prepare them to contribute to discussions and other activities, or reflect on them afterwards. What is linked here is an excerpt from the "Notes on Teaching / Learning Interactions" I wrote for "Critical Thinking" (CCT601) (as revised following the spring offering of this course).

B: Making comments on writing in ways that stimulate rethinking and revision.

Over a number of years my approach to students' assignments has evolved significantly. At first, I wrote very detailed comments and allowed students to revise and resubmit, but the "yield" from my efforts was quite low. Now I respond to their writing in a cover page, do not "copyedit" their prose, and require revision and resubmission. My current approach and the accompanying assessment system is described in exhibit i) from this semester's "Notes on teaching / learning interactions." A selection of students' responses to this are included in exhibit ii).

C: Exposing the constructedness of teaching and learning, and acknowledging the variety of ways that people develop questions and come to know what they know.

In teaching critical thinking it is important to model it during classes. One way that I do this is by making evident the past, present and on-going development of my thinking, not just its polished products. This applies to my thinking about both the process and the content of my courses. Admittedly, some students can be disconcerted by a teacher learning on the job, by the course as "work in progress." Eventually, however, when they appreciate the range of different elements with which their teacher constructs his thinking, they are more likely to reflect upon the analogous constructedness of their own learning and understanding. Moreover, although my experience and my power means that I cannot help being an authority, I want the effects of this authority to be open for discussion and reflection. In general, I find that by acknowledging the variety of ways people develop questions and come to know what they know, students learn more effectively and contribute more cooperatively to the learning of the other members of the class, myself included.

Exhibit i) is an excerpt from my teaching philosophy with notes arising from the early weeks teaching "Critical Thinking" (CCT601). This was handed out to the class a little way into the semester, when some of them were asking for examples of manifestos (a requirement at the end of the semester) and others were asking us to be more explicit about what constituted critical thinking. It was also the basis of one of the monthly CCT faculty discussions in the spring.

Exhibit ii) is an excerpt from a student's evaluation of "Issues in Educational Evaluation" (CCT685), a course that evolved during the semester as I learned on the job.

Exhibit iii) is a mid-semester submission from a Fall 1998 student in "Practicum: Processes of Research and Engagement" (CCT698) who, more than other students, laid out the different strands of her work and continued to develop and rework them.

D: Teaching/learning as a joint dynamic; both learning and teaching benefit from teachers and students viewing the class from both the teacher's side and the students'.
Exhibit i), is a student's unsolicited reflection on "Educational Evaluation," a course that evolved more as we went than my other courses. This same student sent an email early in the course expressing her frustration at the diversity of activities and tasks.
In the past positions I have held "debriefing" sessions after classes, during which two or three students comment on the particular class and on the progress of the course to date. These sessions is more difficult to arrange after evening classes. Email exchanges are a next-best substitute. Exhibit ii) is a student's response to my email reflecting on the previous class in which she presented a map of her project. Exhibit iii) is feedback after students presented on their work in progress.

E: Empowerment to act upon critical thinking, building students' confidence to go beyond simply adopting a critical position.

The CCT Program emphasizes not only critical and creative thinking, but using that thinking to inform practice. To encourage and support students to extend critical thinking into reflective practice it is necessary to take them seriously as individuals. For me, this begins with learning and using students' names by the end of the second week, even in large classes. In large classes it is also not possible to sustain a truly individual-individual interaction with each student that is the ideal of the developmental philosophy (see discussion in the personal statement). However, through small group discussions, peer commentary, work-in-progress presentations on student projects, and, more recently, focused conversations and other facilitated group processes, I am able to bring out many students' voices. As a consequence, I also find that students' evaluations of my courses include more detailed and penetrating observations than those I have seen for other teachers.

The exhibits I have included here are:
i) an excerpt from a student's report, in which she describes her productive workplace use of a group facilitation technique I had introduced in class;
ii) a compilation of "critical thinking manifestos" (at the front of this portfolio). This assignment asked students for "a synthesis of elements from the course selected and organized so as to inspire and inform your efforts in extending critical thinking beyond the course" (see, in particular, the two manifestos marked by post-its);
iii) one student's review of his life in terms of heuristics, which began as a journal entry in

response to a class in which I had introduced the concept of critical (thinking) heuristics; iv) cover notes from some student's portfolios. This end-of-semester assignment (renamed in 99-00 syllabi as a "process review"), called for "4-6 examples of the process of development of your projects and thinking. Journal entries, free writing, drafts, etc. may be included. The point is to demonstrate the development of your work and thinking, not just the best products. Explain your choices in a cover note and through annotations (post-its are a good way to do this)."

F: Advising towards lifelong learning.

Given that CCT students are mostly already working as teachers or in other professional occupations, they have already shown some inclination to life-long learning by joining the Program. Nevertheless, intensive advising is often needed, over and above what courses require, to help them persist through to completion of the Program, weave their studies into their changing work and lives, and turn that inclination into an on-going commitment to life-long learning. (In this regard the testimonials submitted in 1996 by its graduates in support of CCT are very impressive.) My particular emphasis in this first year at U.Mass. has been to cultivate interactions and connections beyond the classroom student-teacher focus. This is evident in:
--the revived CCT web-site (exhibit i), which informs students about the work of previous students;
--a letter (exhibit ii) as acting Program Director to a) solicit information for a directory of CCT students, graduates, and faculty, which will list their interests and projects, and b) initiate a regular forum;
--websites for my courses, with links beyond the course texts (see e.g., http://omega.cc.umb.edu/~ptaylor/698-99p.html); and
--a "briefing" assignment in some courses, through which students cover more topics than is possible in classtime; and help each other address the explosion of information.

For a number of years I have maintained connections with graduates and facilitated connections among them. (An email list, CRITICA-L, has been one vehicle for this.) I write I have on my desk as I write a reprint of an article from Journal of the History of Biology by a former student, Carla Keirns. Although one cannot take credit for the decisions and accomplishments of others, after Carla took courses with me in Biology and Society, her intended career moved from genetics to history and sociology of science, building on her own experience with asthma. I look forward to future reports from CCT graduates that bear some sign of my assisting them in clarifying their interests and career choices, and, in particular, in envisioning their careers in relation to their specific social and personal concerns.

G: Facilitating trans-disciplinary exploration.

My strength as an adviser has always been that helping students explore their wider intellectual and practical interests, and backing up such exploration with bibliographic suggestions and connections to colleagues beyond my home institution. When the students settled on project and thesis topics, I would provide detailed comments on drafts of their writing. At the same time, it has not been straightforward to strike the appropriate student-specific balance between facilitating trans-disciplinary exploration and maintaining the rigor of discipline-based inquiry. In CCT, although the Program has its roots in the fields of philosophy, psychology, and education, the scale is necessarily tipped towards the trans-

disciplinary. That is, students' interests almost never lie within conventional disciplinary boundaries.
My efforts to facilitate trans-disciplinary inquiry are illustrated in the project topics from the Practicum course in the fall of 1998.

<--Previous | | Table of Contents for: Exhibits | | Next-->

---

3. On-going development of pedagogy.

My commitment to developing science-STS teaching has led me to experiment, innovate and develop better ways to learn from teaching about teaching and learning. This now continues in learning to teach CCT and is evident in five features of my work that are described in the following sections.

A: Developing a large range of CCT courses.

Taking into account the small number of CCT faculty and the need to provide both required courses and a range of electives, I have already developed six courses for CCT and made significant revisions to a seventh (CCT601). Except for the last one, all the syllabi are entirely different from those of previous instructors, either because I built the course around a new theme, injected new approaches to the subject, or did not have access to previous syllabi when I designed the course. To see the range of these courses, refer to section I.

B: Experimenting to develop pedagogical approaches specifically tuned to STS and CCT and their open-ended state as fields

There are few models for teaching critical thinking, especially about science. As indicated in the personal statement, I have sought out ideas for classroom and group process techniques in a variety of venues (see exhibit i), a reflection on different approaches to learning styles and group process which has subsequently informed my teaching and advising of CCT teachers interested in different learning styles).
Moreover, just as I expect of my students, I experiment, take risks, and through experience build up a set of tools that work for me. Some of my pedagogical experiments over the last year are illustrated in the exhibits included here:
ii) the handout I prepared for an early meeting of this fall's faculty seminar on "becoming a teacher-researcher";
iii) the gallery walk, an ice-breaker for the first Education Evaluation class, adapted from a workshop I attended the previous November; and
iv) an example of a student's briefing on one of the course texts. This assignment directed attention to the insights and details of the course text without taking time away from activities and discussion to present lectures. Students were asked to go deeply into one or two chapters of the text and produce a briefing that would give other students a quick start if they were to address the issue or topic of those chapters. The compilation of briefings was distributed to all students.

C. On-going development of courses

My courses develop a) in response to new developments in the sciences and STS interpretations of those sciences; b) as I address the difficulties and challenges of teaching critical thinking and education more generally; and c) in response to suggestions from students and course evaluations. I no longer keep Teaching Notebooks to document this process of development, but instead enter proposed changes to each course syllabus directly into a revised version on my computer, in footnotes to that revised syllabus, and in a "to do" list for each course. Of course, some of my handwritten annotations made during class remained only on my class notes, not transcribed into these computer files. I make further changes and add to that "to do" list after digesting the written comments in end of semester evaluations.

The two exhibits included here convey the effort I put into self-assessment of my courses and thinking about improvements:
i) A snapshot from the "to do list" I keep on my computer for CCT 601. (Because these notes were not written to be read by someone else, they will be somewhat cryptic, but they should convey the active process occurring); and
ii) The revised syllabus "Practicum: Processes of Research and Engagement" (CCT698) as produced during and after the fall 1998 semester. This should be contrasted with the original fall 1998 syllabus, and the current fall 1999 syllabus, both included in section I.2.

D: **Varieties of course evaluation, integrated into the teaching/learning process.**

End of the semester course evaluations have four potential audiences and goals:
i) The professors -- to guide them in continuing to develop the course
ii) Future students -- to guide them in choosing courses, and knowing what to expect
iii) Current students -- to allow them to take stock of how to get the most from courses and teachers in the future
iv) Colleagues and superiors -- to make decisions about promotions and about support to give to courses
Standard course evaluations, especially computerized ones, address few of these audiences / goals well. For several years I have used my own written course evaluation, which begin with a student self-evaluations (goal iii), and ask for synthetic statements to be submitted later (goals i & iv) (the return rates are only moderate). Through written evaluations students not only provide more guidance about how to improve teaching, but also reflect on how they can get more from classes. In recent years, before students write their end-of-the-semester course evaluation, we make time for spoken appreciations, reflections of students' responsibility in the course, and suggestions for changes (goals i & iii). I used to summarize the written evaluations (goals i & iv), and distribute the summary to new students on the first day of the following year's course or on the course website (goal ii). I have been unable to make time for this at U. Mass., but hope to be able to include on course websites a summary of what I plan to work on from the evaluations plus the full (scanned-in) text of the evaluations. The diversity of students' concerns strikes me as important to convey to future students, so I am becoming less committed to summarizing the written responses. In this spirit, I have begun to facilitate evaluation activities that aim for the whole group to share and make sense of a common pool of experiences of the situation (exhibit iii).
Exhibit i) is the course evaluation activity I designed for "Critical Thinking" (CCT601). Exhibit ii) is a summary submitted by one of the groups of 4 (see exhibit i). Unfortunately, we received few of these and needed to supervise more closely their completion.
Exhibit iii) is the historical scan activity refered to in the personal statement.

I also incorporate course evaluation during the semester (goals i & iii). I often solicit email exchange (see exhibit 2.D.2) and this last year experimented with a number of forms of feedback, including:
Exhibit iv)--a "best and worst" grid in the "Practicum" (CCT698), which asked students to reflect back on their best and worst experiences in cultivating and on this basis make suggestions elicit ideas about how to foster the processes
Exhibit v)--the final product of a "card-storming" activity early in "Issues in Educational Evaluation" (CCT685). In this activity individuals defined elements of their vision for the course--what they would like to happen--and then these were grouped and named by the class as a whole, give or take some post-class input by me after we ran out of time.
Exhibit vi) is the summary of responses to a "Critical Incident Questionnaire" completed by students at the end of class during the early weeks of my spring courses.

The commitment to integrating evaluation into a teaching/learning process is also evident in this portfolio itself. It is designed to provide many more bases for future interactions with my colleagues about teaching than a standard compilation of course syllabi and evaluations.

E: Promotion of teacher-teacher interaction.

Over a number of years I have made opportunities for receptive colleagues and students to observe each other teach. The role of observer has, for me, clarified many elements of engaged and engaging teaching. This fall's faculty seminar on "Becoming a teacher-researcher" is providing more opportunities to experience the value of another's observations. Other recent efforts to stimulate give-and-take around teaching include:
i) a three hour Honors Faculty Development Workshop I led last June; see the handout I prepared to accompany this; and
ii) a college faculty and graduate student workshop I am organizing; see the two excerpts from the prospectus for this workshop. (Originally this was scheduled to precede the July 26th. practitioners workshop, but has been postponed to a weekend to be determined.)
See also exhibits 1.E. ii-v) concerning the Practitioners' workshop and "Changing Life" working group.

<--Previous | | Table of Contents for: Exhibits

---

4. Heterogeneous construction as a model of agency

By exposing points at which the science could be--or could have been--pursued differently, reciprocal animation and critical thinking open up a more difficult issue: Through what processes are alternatives actually realized? My STS work emphasizes how, in order to know the world and practice their science, scientists harness diverse resources--from funding opportunities to metaphors, status hierarchies in their discipline to data available/collectable given the time allocated for the study. As a teacher I therefore highlight the diverse kinds of practical measures, not just conceptual shifts, needed to modify the development of the episode of science we are considering. Of course, the particular resources and their inter-linkages making up such *heterogeneous constructions* differ from case to case; reconstructions of their complexity require considerable practical experience. Whether or not I introduce the

concept explicitly, I try to make heterogeneous construction accessible to students through exercises in which they attempt to map the diversity of influences on their own development, the ways these build on each other over time, and the different potential points of intervention. After achieving only moderate success getting students to do this in the "Thinking, Learning, and Computers" course, I developed the framework included as an exhibit here, with which I hope in the future to better shape students' thinking.

Heterogeneous constructionism is allied to constructivism in education with its emphasis on students learning concepts by (re)discovering them for themselves, but extends this by tying of conceptual themes strongly to practical ones. Eventually, I hope, I will refine ways to stimulate students even in the short span of a semester to bring a heterogeneous constructionist view of agency to bear on their own research, applications of science, teaching and other social interventions.

EXHIBITS
related to
Service and Institutional Development

The exhibits have been selected to illustrate the four sections discussed in Section III of my personal statement, plus some other material.
(Arranged in chronological order within each section. When no link is given, the exhibit is available in hard copy only.)

Building a Basis for Interdisciplinary Science and Environmental Education

- 1991-2000 / / Contents pages for special editions of journals emerging from conference sessions I organized
- 1999, Spr. / / Flyer advertizing Changing Life working group
- 1999, June / / Critical Thinking Workshop hosted by Board of Higher Education
- 1999, July / / Prospectus for July '99 Science-in-Society practitioners' conference
- 1999, Aug. / / Evaluation of Science-in-Society workshop
- 1999, Fall / / Final report of Committee to establish a math/science track within the M.Ed. program
- 2000, Sept. / / Report on Faculty Development workshop, July 2000
- 2000, Nov. / / Program for initial session of Eisenhower Professional Development Course for math and science teachers
- 2000, Nov. / / Summary of responses from Ice-breaker activity in the above program
- 2001, Mar. / / Letter of appreciation for consulting in design of international environmental studies workshop
- 2001, Apr. / / Science education search‹rubric to evaluate finalists
- 2001, July / / Program and Participants in Faculty Development workshop

Ensuring a Viable Critical & Creative Thinking (CCT) Program without the Other Full-time CCT faculty Member

- 1998-> / / CCT Web Page
- 1999-> / / Reliable Roster of CCT course offerings
- 1999-> / / A sample page from the updated CCT database
- 1999, Fall / / Program for Critical and Creative Thinking Forum
- 1999-> / / Handbook for CCT students
- 2000, June / / AQUAD Planning Document for CCT Program
- 2000-01 / / Publicity Brochures for CCT
- 2000-> / / Tracking Sheet for Applications to CCT
- 2000-> / / Links to allied organizations through the internet
- 2000, Sep. / / Directory for CCT Community
- 2000, Sep. / / Feedback from the CCT Community
- 2000, Fall / / Program for Critical and Creative Thinking in Practice
- 2000-> / / Operations Manual for CCT Office

- 2000, Fall / / Guidelines for Preparation of CCT Synthesis
- 2001, Apr. / / CCT in Practice Open House
- 2001, Sep. / / CCT Orientation and Community Gathering

Developing CCT in New Directions

- 2000, Spr. / / Prospectus for Outreach Unit, Thinking for Change
- 2000 / / Presentations for Center for Improvement of Teaching

Clarifying and Strengthening CCT's Status in the Graduate College of Education and UMass Boston

- 2000, June / / AQUAD Planning Document, see section on parameters for planning *Service beyond CCT*
- 2000, Fall / / Academc Affairs & Curriculum Committee Guidelines
- 2000, Dec. / / Educational Technology Guide produced for Dean's Task Force
- 2001, May / / Guide for Professional Development in Educational Technology, produced as MEET fellow for GCOE (draft)

Other

- 1998, Fall / / Spreadsheet to facilitate processing of course evaluations
- 1999, Nov. / / Departmental Personnel Committee report
- 2001, Apr. / / Science education search‹rubric to evaluate finalists