Master of Science in Biology for Teachers

Self-study for 11/2007 review

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Section A. General self-evaluation

Program overview

The Master of Science in Biology for Teachers (MSBT) is a flexible 36-credit (1+ year) program that prepares biology teachers to present science as a process rather than simply a body of information. As scientists know, but the public doesn't always appreciate, science is not a set of facts, but an approach to learning about the world, in which questions are asked and answered based on experiments or structured observations and analyses. Science educators know this, and in recent years inquiry-based learning has become a popular buzzword in science education. However, although the core of scientific discovery is research, few precollege science teachers have ever had the opportunity to participate in a significant research project themselves. The primary goal of the MSBT program is to remedy this weakness by providing K-12 biology teachers an opportunity to carry out an independent research project in a University research lab under the supervision of a professional scientist. The hope is that the experience these teachers gain through these projects will make them better able to help their own students understand how science is really done, rather than how it is presented in textbooks. To quote Rob Steiner, a former MSBT student mentor and member of the MSBT steering committee, "Science is about doing- more than knowing, and I am personally persuaded that that there is something transformative about actually participating in scientific inquiry. Having our teachers work as scientists at the frontiers of discovery and contribute something essential to the intellectual and physical journey is a rite of passage that can only help our teachers become better educators."

The MSBT program requires that students take up to 30 credits of course work in a variety of fields (see section F), but the core of the program is the research project. While not as detailed or involved as a full-fledged Master's thesis, the research project is expected to involve all the basics of scientific investigation: formulating a hypothesis, collecting and analyzing data, testing the hypothesis, drawing conclusions, and presenting the results in both written and oral formats. Students must have enough freedom and independence to make mistakes along the way, so that they learn that science is a messy, start-stop-recover-start again process rather than the clean sweep of discovery outlined in published articles. The study takes approximately one quarter of full-time work (or an equivalent amount of time spread out over a longer period) and concludes with a written report, prepared as if for publication, and an oral presentation to a committee of MSBT faculty.

One of the strongest aspects of the MSBT program is its flexibility. Students may take courses in any department, which lets them put together meaningful programs that meet their needs as teachers, and at the same time fit with their often demanding work schedules. Students may work with any University faculty member and are responsible for finding an adviser and working out an appropriate topic. Student projects have historically covered a broad range of topics and supervising departments, from "SIV envelope variation and the development of neutralizing antibodies" (Jeanne Ting Chowning, Microbiology and Pathology, School of Medicine) to "Birds on loan: measuring the extinction debt of urbanization" (Cara Ianni, College of Forest Resources). See Appendix I for a complete list of recent students, projects, and advisers. Faculty participation in the program is strictly voluntary, but most UW faculty are enthusiastic

about supporting K-12 science education and students have typically had no difficulty getting faculty to agree to sponsor their research.

Self-evaluation

Since the MSBT program has no core faculty, the customary statistics about teaching and research productivity (student credit hours, grants received, publications produced, etc.) are not appropriate metrics for evaluating it. We measure the success of the program through the success of our graduates and the changes it makes in their teaching careers. Their responses to a recent questionnaire (Appendix K) suggest that the program has been valuable indeed to its graduates.

Among the 38 graduates from the MSBT program in the last ten years, 84% are currently employed in science education (see Appendix E, Placement of Graduates). The majority (50%) returned to the K-12 classroom, often accepting more challenging assignments such as teaching Advanced Placement and honors biology classes. Several, such as Nancy Canino (1997) and Martha Stachans (2003) are now science department chairs, Jack Mehn (1999) is Dean of Students at Walla Walla HS, and Tim Krell (1998) is the principal of a junior high school. Others left the classroom to take positions in K-12 science outreach. For example, Jeanne Chowning (2004) left Bellevue HS to become the education director for Northwest Association Biomedical Research, and Tom McDonald (2005) owns and operates an environmental education adventure company for American high school students in Costa Rica. Several have faculty positions in higher education: Don Heins (1998) teaches biology at Bellevue Community College, John Moffat (2006) at Seattle Central Community College and Cindy Updegrave (2007) at UW's Community Environment and Planning program. Five of our recent graduates are currently enrolled in or have completed doctorate programs in science. For example, Kathy Hall (2005) is in the second year of an individual Ph.D. program at UW combining Biology and Education, and Stephen Larner (2000) completed a PhD in neuroscience at the University of Florida in 2004. Dr. Larner is currently employed as research faculty in UF's McKnight Brain Institute. Among the informal science educators who graduated from our program (23%), many now hold positions of importance, especially in environmental education. Cara Ianni is the education coordinator for the Stilly-Snohomish Fisheries Task Force, Judy D'Amore is the education director for Port Townsend Marine Science Center, and Alicia Blood is the youth development director for the YMCA's Earth Corps. In summary, the fact that such a high percentage of our graduates remain in science education, and the success of their careers speaks to the success of our MSBT program.

Governance

The MSBT program is small (admitting 5-8 students/year) and runs almost entirely on volunteer labor. The program is overseen by an interdisciplinary 12-15 member Steering Committee (Appendix D) that meets annually to monitor program activities and set overall policy. The Steering Committee currently includes faculty from the College of Arts and Sciences, College of Education, College of Forest Resources, School of Medicine, and the College of Ocean and Fisheries Sciences. The Steering Committee Chair, Professor Douglas Sprugel of the College of Forest Resources, also serves as the Graduate Program Coordinator. Helen Buttemer, lecturer and Program Director for the Biology Department's Biology Program for Teachers, serves as Graduate Advisor and does all programmatic student mentoring and advising, as well as other administrative tasks. However, the bulk of the actual teaching in the program is done by the faculty who serve as advisers and mentors for the student research projects. Neither these

faculty, nor those who serve on the Steering Committee, receive any compensation from the program for their volunteer efforts.

The program is administered directly by the Graduate School, which is appropriate for an interdisciplinary program that draws on faculty from and distributes students to many different Departments, Colleges and Schools across the campus.

Role in the University

The UW Mission Statement states that "We promote access to excellence and strive to inspire through education that emphasizes the power of discovery and the foundation of critical and analytic thinking." It is difficult to see how any program could be more appropriate to the University's mission than one that provides science teachers access to the UW's excellent faculty to enable them to pass the excitement of discovery on to their own students.

Changes since the last review

The main change since the last review has been a substantial increase in the number of students in the program, due at least partly to an expansion of our target population. Since 1997 we have begun to serve not only biology teachers in high school and community colleges, but also teachers of informal science, such as environmental educators, science educators in museums etc. We felt that this was an important population of science educators not well-served by science departments who would benefit from an opportunity to improve their understanding of biology teaching and who would be eager to participate in the degree program. Since 1997, 13 of the 48 teachers admitted to the MSBT program have identified themselves as 'informal' science educators (representing approximately 25% of the student body); the remaining 35 were traditional junior high or high school biology teachers.

One of the most important groups we have reached out to with these changes has been environmental educators, many of whom work in environmental learning centers rather than regular schools. Many of these students have come to us through the close relationship we have maintained with IslandWood, a new $50 million environmental learning center on Bainbridge Island that provides week-long environmental education programs to 4th and 5th graders in the Seattle Public Schools. Former MSBT Chair Johnny Palka and current Steering Committee member Mark Windschitl were closely involved with IslandWood during its formative period (http://www.islandwood.org/about/history.php), and assisted them in developing a 10-month residential graduate certificate program to train future environmental educators through an experiential, hands-on model of learning. This collaboration resulted in linkages between the IslandWood graduate certificate program and several graduate degree programs at UW. As a result, many students who finish the certificate program at IslandWood come to UW to get an advanced degree, and those with strong interests in biology research often find the MSBT program a congenial way to continue their education.

Another change since the previous review has been a change in core course requirements for the MSBT degree. When the program was started in 1967 students were required to take one course in each of the following areas:

Botany
Zoology
Microbiology
Genetics

Biochemistry (unless previously completed as an undergraduate)
Science Education

These taxonomic areas covered the standard subdivisions of biology in the late 1960's, and not coincidentally, corresponded with departments that existed at that time. However, since the 1960's biologists have tended to focus more on levels of integration rather than taxonomic units, and many of the departments from that period have been merged or recombined. To recognize these changes, beginning in Autumn 2007 students will be required to take course work in five of the following six areas:

Biochemistry/cell biology
Genetics
Physiology
Biodiversity/natural history
Ecology
Evolution

Science Education is still required. We believe that these new requirements are more consistent with the structure of biology in the 21st century, and in addition the encouragement to take a course in Evolution will better equip teachers to deal effectively with one of the most pressing issues in science education today.

Challenges

The weaknesses of the MSBT program are largely inherent in its structure and target population. Historically the program has been targeted at established certified biology teachers who want to improve their skills and teaching ability. However, established teachers almost by definition have homes, jobs, and financial responsibilities, so it is usually difficult for them to take a full year off from classes. While the University offers some evening and weekend classes, MSBT students are usually interested in lab and field classes that demonstrate techniques that can be translated to the K-12 classroom, and these are generally taught during the regular class day.

We have dealt with this problem in two ways. First, as described above, we have expanded our clientele to include environmental educators and other teachers of informal science. Many of these students are younger than the traditional teachers we had formerly targeted, with fewer responsibilities and commitments, which has made it easier for them to attend school full-time and take courses taught during the normal working day. Second, we have attempted to provide at least some funding for students during unpaid leave from their K-12 teaching positions. Since 2001 we have had an annual Graduate School Fund for Excellence and Innovation (GSFEI) allocation of one RA position per year, which we have generally divided into 3 quarter-long appointments and used to support select MSBT students during the research phase of their program. 17 MSBT students (about 34% of all students) have received one-quarter of RA support through this program. In addition, many MSBT students have been successful in finding independent funding outside of Biology Teaching, such as by serving as TA's for introductory courses. Finally, the Biology Department biannually awards a Charlotte M. Crary Scholarship in the amount of $4000 to a student in the MSBT program supporting the development of a K-12 classroom project from the student's research. All of these programs help support MSBT students, and have helped to alleviate some of their financial challenges.

In preparing for this review, we sent a short questionnaire to all faculty who have mentored MSBT students in the past 5 years. Responses are attached as Appendix J. Most faculty were enthusiastic about the program and the students they had mentored, but two criticisms appeared multiple times. The first was that the time available to finish the research project was too short. This is somewhat inevitable given that this is a one-year program, but has become more of an issue with the newer generation of younger students, many of whom work on their projects full time and complete them within a single quarter. More traditional students with outside responsibilities are more likely to work on their projects part-time, which means that even if they spend the same number of hours on the projects, the total duration is longer. There is no easy solution to this problem, since it is inherent in the structure of the program. A second problem was that faculty mentors were often unsure about what the expectations for the project were, especially at the start of the project. Now that we are aware of this problem we will developi some written information we can send out to mentors when they agree to take on an MSBT student, and also make personal contact with them at the beginning of the project as well as at the end.

Prospects for the future

The MSBT program has grown steadily over the past 10 years (see list of admissions, Appendix A), as a result of national recognition of the importance of discovery-based learning, improvement in the support we have been able to offer our students, and expansion of our clientele including our relationship with IslandWood. The program appears to be financially sustainable as it currently operates, since the Biology Department supports the program fully and will continue to provide partial salary for the Graduate Advisor (see Appendix L). Other costs to the University are small. The current Graduate Program Coordinator, Doug Sprugel, will retire from the University in the next few years, but there are several current members of the Steering Committee who could easily replace him. The Program Assistant, Helen Buttemer, would be harder to replace, and when she retires it might be appropriate to re-evaluate the program's structure, governance, and support.

We believe we are close to the maximum reasonable size with the current staffing and all-volunteer faculty participation. The applicant pool could probably be increased substantially by advertising the program more aggressively in schools and environmental education centers, but any major growth would require a significant increase in resources and probably a dedicated full-time staff member to handle advising and administrative issues. Unless the University is willing to considerably increase its financial commitment to the program, we believe the best course for the near future is to maintain the program at its current size and strive to serve both students and faculty mentors more effectively.

Section B (Teaching) and Section C (Research and Productivity)

Since we have no core faculty and teach no courses, individual-based measures such as student credit hours, grants received, or publications are not appropriate for this program.

Section D. Relationships with other units

The MSBT program is entirely interdisciplinary. It is housed in the Biology Department, which has been very supportive of the program, and provides mail boxes for our MSBT students, encourages our students to attend all departmental functions, features photographs of our students along with the department's display of grad students, and supports the Biology Teachers' Resource Center, an invaluable resource for our students as well as others interested

in K-12 biology teaching. Salary support for the Graduate Advisor is also provided by the Biology department. However, both the Steering Committee and faculty mentors cut across all departmental and College boundaries (see Appendices D and I) Students are encouraged to forage widely to find courses and advisers appropriate to their interests, and the wide range of student interests ensures a continued diversity of participation in the program. No problems have ever arisen from this arrangement, and we do not anticipate any as long as the program stays small enough that it does not demand excessive contributions of time from any one department or individual.

Section E. Diversity

The MSBT program has never dealt explicitly with the issue of diversity. The Steering Committee is 36% female including one Asian-American woman. The Graduate Program Advisor is female. Our student body is primarily female (61%). In the past ten years, we have admitted 27 white females, 14 white males, 4 Asian American females, one Hispanic male, one Hispanic female, and one African American male. We have not actively sought to recruit students from underrepresented groups, at least partly because we do almost no recruiting of any kind (see Overview).

Section F. Degree Program

Program requirements

Course Work

The M.S. in Biology for Teachers is a very flexible program for biology teachers who wish to expand their understanding of biology. The minimum requirement for the degree is 36 credits; 18 of which must be graduate level and 18 must be graded. These categories are not mutually exclusive. Each student plans a program to meet his or her own educational objectives selecting coursework in 5 out of 6 areas of biological sciences (biochemistry/cell biology, genetics, ecology, evolution, biodiversity/natural history, physiology) and at least one course from science education. Courses in Biology, Biomedical History, Fisheries, Forest Resources, Medicine, Genome Sciences, Environmental Health, etc. may be appropriate for the student's interests and should be noted while the program is being planned. The Graduate Program Adviser assists the student in this planning. All course work must be at or above the 400 levels.

The Project

A graduate research project (6-9 credits) is required for the degree. The project represents an opportunity for the biology teacher to become a practicing scientist and develop a depth of understanding of the methods and significant questions in research. Under the guidance of a sponsoring professor the student carries out an intensive field or laboratory study. In general, the topic should have direct relevance to the student's primary concern with teaching. The study takes approximately one quarter and concludes with a written report, prepared as if for publication. This serves as the background for assessment at the final oral examination by the student's advisory committee.

Additional features

While the program may be completed in 3-4 quarters of full-time study, full-time attendance is not required. A student has six years to complete this degree and may attend part-time or during summers.

There is no foreign language requirement.

How do we measure success?

There are easier pathways to a master's degree for a teacher. While the specific aim is to assure distribution of course work toward the degree among the major areas of the biological sciences along with some study in science education, the core emphasis of the degree remains the experience with scientific research in an established laboratory. In this way, teachers learn directly about the nature of science and the pursuit of new knowledge. At the end of the research experience, a report is written followed by an oral examination with the student's committee in which the student outlines the research topic, discusses the process of hypothesis formation, the analysis of the data and the relationship of the evidence to the hypothesis. The examining committee composed of the principal research scientist and members of the MSBT Steering Committee quiz the teacher at length about the experimental results, the nature of evidence, his or her general understanding of the nature of science and the application to teaching science in the K-12 classroom. These examinations are rigorous and a good measure of the success of the program. Based on the quality of the research projects produced by MSBT students during the past ten years (Appendix I), we feel confident that our program effectively trains teachers and meets the goals of the national science education reform agenda:

> "Students at all grade levels and in every domain of science should have the opportunity to use scientific inquiry and develop the ability to think and act in ways associated with the processes of inquiry, including asking questions, planning and conducting investigations, using appropriate tools and techniques, thinking critically and logically about the relationships between evidence and explanations, constructing and analyzing alternative explanations, and communicating scientific arguments."
>
> *(NRC 1996, in National Science Education Standards p. 105)*

For the most part, our graduates remain in the field of science education. 84% of the graduates from the past ten years are currently employed in education related fields (see Appendix E). Most attend our program part time while maintaining employment, generally as a biology teacher in a secondary school. Some do attend full time and either take sabbaticals from their teaching positions, or interrupt a teaching career to pursue the degree. In almost all cases, they return to the classroom. In recent years, a number of newly trained environmental educators (from IslandWood Environmental Learning Center) have used the MSBT degree to improve their professional credibility and launch successful new careers in the field of public/environmental education. We maintain a close relationship with most of our graduates – results of a recent survey are attached (Appendix K).

Section G. Graduate Students

1. Recruitment and retention

Our clientele has changed slightly over the past decade. As noted in the overview, we have expanded the program to include not only teachers of high school biology and community college but also teachers of informal science, such as environmental educators, science

educators in museums etc. We felt that this was an important population of science educators not well-served by science departments who would benefit from an opportunity to improve their understanding of biology teaching and who would be eager to participate in the degree program. Since 1997, 13 of the 48 teachers admitted to the MSBT program have identified themselves as 'informal' science educators (representing approximately 25% of the student body); the remaining 35 were traditional junior high or high school biology teachers. In recent years, we have permitted select students (6 total) in the College of Education teacher certification program to informally link the Masters in Teaching degree (MIT) degree with our MSBT degree.

The retention rate for the last 10 years is 85%. Since 1997, the MSBT program has admitted 48 teacher applicants including 6 informal concurrent degree applicants, linked with MIT (Masters in Teaching, College of Education). Of the 48 admitted, 3 transferred to other graduate programs, 2 withdrew without beginning the program, and 2 left with no contact. Among the remaining 41 students: 26 have graduated and 15 are either enrolled, on-leave or inactive but plan to complete the degree at a later date. Since our students are for the most part practicing teachers with career obligations, the average time to completion for the degree is approximately 4.1 years. Occasionally students leave the program without submitting an on-leave petition which nullifies their status with the Graduate School. However, we remain in close contact with these students and with encouragement, they generally return to complete the degree. Attrition is low.

2. Advising, Mentoring and Professional Development

Helen Buttemer acts as the Graduate Advisor and Graduate Program Assistant for the MSBT program. She does this as part of her duties as the director of the Biology department's Biology Programs for Teachers which also includes advising biology undergraduates preparing to enter teacher certification programs, directing the HHMI teacher outreach programs, and working with the College of Education on K-12 teacher-related projects. In addition, she is a part time lecturer for Biology, teaching courses for pre-service and in-service teachers.

This program is intended for highly motivated and self-directed individuals. The typical MSBT student attends UW part time while maintaining a professional teaching job. Students come from as far away as Utah and Colorado, attending in the summer or, if fortunate, are able to take short leaves from their teaching positions to attend UW for one to two quarters. Even those who work locally often have difficulty arranging time off to attend the program. The average time to completion is about 4 years, including long periods in which the student requests on-leave status. There is no one quarter when the majority of the students are together on campus. Consequently it is difficult to create a cohesive student body. Once per year, during Autumn quarter, all students are invited to attend an MSBT program social function and general meeting. The purpose of this meeting is to provide students with the opportunity to interact with each other and faculty, share experiences and generally feel like they belong. Students are also invited to attend all Biology departmental functions such as the Christmas party, and the Spring BBQ. However, attendance at these functions has been poor, in part due to the many obligations of our working student population. Contact with the Graduate Advisor is the primary connection to the program, at least until the research experience is underway. After that, the student develops a closer relationship with the sponsoring professor who becomes their mentor, and with other graduate students in the research laboratory. Unfortunately the research experience is short, typically one to two quarters, and occurs towards the end of the students' time at the university. It should be also stated that the majority of our students are very appreciative of the flexibility of the program even though some regret the absence of a cohesive cohort of fellow students in the program – results of a recent survey are attached (Appendix K).

Since most students attend the UW part time, advising is subject to the availability of the student. Email has been very successful in providing for the nontraditional students' needs. The Graduate Advisor meets in person with all full time and part time MSBT students, generally once per quarter to help them plan their program, select appropriate courses, find research opportunities for the required project, set up the final examination committee, and intervene on their behalf whenever necessary with the Graduate School. Since the course requirements for the MSBT degree are very flexible, most students are able to plan a program that simultaneously allows them to pursue unique academic opportunities available at UW while accommodating working schedules. All students, including those on-leave, receive regular emails from the MSBT program informing them of upcoming student research presentations and other program events, news, employment notices, research opportunities, interesting courses as well as funding opportunities.

Advising issues related to the research experience are referred to the Graduate Program Coordinator and chair of the MSBT Steering Committee, Doug Sprugel, professor in CFR. Both the Graduate Program Coordinator and the Graduate Advisor attend each student's final examination in which the research project is discussed and graduation is approved.

Since our students are by definition teachers, we do not have a professional development plan. We do however, regularly inform both our current students and our graduates of relevant job opportunities byway of email notices. Potential employers are very interested in our graduates and often request that we advertise relevant teaching positions. One average, we notify our students of 1-2 job opportunities per week. The majority of our graduates remain in the field of education (see Appendix E).

3. Inclusion in governance and decisions

We seek advice and comments from students whenever major changes are made in the program, and recently conducted a survey of recent graduates (Appendix K). To the best of our knowledge, no grievances have been lodged in the history of the program. Students are encouraged to participate in the Graduate Student Senate. However, participation remains low likely due to the fact that the majority of our students attend part time, or otherwise are employed. Students in the MSBT program are, for the most part, older and have families and/or professional responsibilities; they tend to have little free time.

4. Graduate student service appointees

Beginning in 2001, Biology Teaching was awarded an annual GSFEI allocation in the amount of one RA position per year. This funding is generally divided into 3 quarter-long appointments and used to support select MSBT students during the research phase of their program. Since 2001, 17 MSBT students (about 36% of all students) have received one-quarter of support enabling them to devote themselves more fully to the research experience. Students apply in writing and are awarded funding based on financial need and involvement in the field or lab component of their research project. These appointments have been used to help support teachers during unpaid leave from their K-12 teaching positions. Supervision is by cooperating research faculty and by Helen Buttemer, graduate student advisor.

Many MSBT students have been successful in finding independent funding outside of Biology Teaching. For example, the Biology Department often employs our students as TA's for introductory courses. In addition, the Biology Department biannually awards a Charlotte M.

Crary Scholarship in the amount of $4000 to a student in the MSBT program supporting the development of a K-12 classroom project from the student's research. This is another example of the excellent relationship the MSBT program has with the Biology department.

APPENDICES

Required:

Appendix A. Graduate Student Statistical Summary (10-year data)
Attached

Appendix B. Academic Unit Profile
Not applicable: Omitted

Appendix C. List of special pathways, options, certificates, etc. within degree
None: Omitted

Appendix D. List of faculty by rank; include list of dissertation committees chaired for past five years
No core faculty. Substituted: list of steering committee members

Appendix E. Placement of graduates, last 3 years (include data on placements outside the academy)
Attached

Appendix F. Academic Unit's mission statement
Omitted—none.

Appendix G. Abbreviated Faculty Curriculum Vitae
Attached

Appendix H. HEC Board Summary
Attached

Additional appendices:

Appendix I. Recent MSBT Students, Projects, and Advisers
Attached

Appendix J. Responses to faculty questionnaire
Attached

Appendix K. Responses to student questionnaire
Attached

Appendix L. Supporting Letter from Biology Department
Attached

Appendix A. Graduate Student Statistical Summary (10-year data)

MSBT PROGRAM INTERNAL STATISTICS, 1997-2007

STUDENTS ADMITTED PRIOR TO 1997 (ACTIVE as of 1997): 12

STUDENTS ADMITTED SINCE 1997: 48

1997: Stephen Larner (2000), Claire Olsovsky (1998)

1998: Eric Nelson (withdrew)

1999: Susan Daughters (2001)

2000:James Doyle (2003), Thomas McDonald (2005), Danica Ready (2000), Martha Strachans (2003)

2001: Alicia Blood (2004), Jeannie Chowning (2004), Cynthia Updegrave (2007), Gail Nitta (withdrew), Cara Ianni (2003)

2002: Jamie Wakefield (2003), Elise Cooksley (2006), Rhonda Schmidt (withdrew), Heather Neel (2006), Veronica Mantel (2003),

2003: Casey Ralston, Alfred Sidman, Deborah Goodwin (2004), John Moffatt (2006), Nathan Oxnard (2006), Michelle Rogers (2005), Megan Heckert (withdrew), Brian Alfertig (inactive)

2004: Glen MacMaster (2007), Rachel Tomco, Katharine Hall (2005), Oliver Jones (2007)

2005: Emily Elasky, Gary Gant, Kati Halmos, Matthew Hinckley (inactive), Rex Lyband, Mary Mendenhall, Nelly Tsai, Benjamin Perrin (withdrew), Esther Munoz, Sarah Frame (2007)

2006: Cathy Buck (2007), Jason Boatwright, Kathleen Henson. Alyssa Matthews (2007), Jennifer Todd (2007)

2007: Yana Radenska, Royce Hale, Linda Uyeda

(parentheses) = graduation date

STUDENTS GRADUATED WITH MS: 38 (end Summer 2007)
AVERAGE TIME TO COMPLETION: 4.1 YRS

Alicia Blood, 2001-2004
Cathy Buck, 2006-2007
Nancy Canino, 1990-1997
Jeannie Chowning, 2001-2004
Elise Cooksley, 2002-2006
Lisa Comiskey, 1996-1999
Judy D'Amore, 1989-2000
Susan Daughters, 1999-2001
James Doyle, 2000-2003
Sara Frame, 2005-2007
Deborah Goodwin, 2003-2004
Katherine Hall, 2004-2005
Donald Heins, 1991-1998
Riley Hoselton, 1993-2000
Cara Ianni, 2001-2003
Oliver Jones, 2004-2007
Tim Krell, 1993-1998
James Kwan, 1990-1998
Stephen Larner, 1997-2000
Jennifer Lutz, 1991-1998

Veronica Mantel, 2002-2003
Alyssa Matthews, 2006-2007
Glen MacMaster, 2004-2007
Thomas McDonald, 2000-2005
Jack Mehn, 1994-1999
John Moffatt, 2003-2006
William Monahan, 1992-2002
Heather Neel, 2002-2006
Claire Olsovsky, 1997-1998.
Nathan Oxnard, 2003-2006
Danica Ready, 2000-2000
Bryan Robles, 1994-2002
Michelle Rogers, 2003-2005
Martha Stachans, 2000-2003
Jennifer Todd, 2006-2007
Cynthia Updegrave, 2001-2007
Jamie Wakefield, 2002-2003
Carl Wigren, 1995-1997

STUDENTS TRANSFERRED, WITHDRAWN OR LEFT PROGRAM WITH NO CONTACT: 7

Brian Alfertig, S'03	Attended one quarter S'03. No contact.
Megan Heckert, A'03	Did not attend
Matthew Hinckley, W'05	Informal concurrent with MIT/graduated. No contact.
Eric Nelson, A'98	Transferred MEd W'99
Gail Nitta, A'01	Transferred to another graduate program W'02
Benjamin Perrin, A'05	De-enrolled A'05, GNM
Rhonda Schmidt, A'02	Transferred to PhD program CFR

STUDENTS INACTIVE (FAILED TO FILE ON-LEAVE PETITION BUT PLAN TO COMPLETE DEGREE): 6

Gary Gant,	informal concurrent MPH/graduated
Rex Lyband	last enrolled S'06
Esther Munoz	last enrolled S'05, on leave through S'06. Contact spr'07
Mary Mendenhall	informal concurrent MIT/graduated), last enrolled S'06
Alfred Sidman	last enrolled A'06
Rachel Tomco	last enrolled S'06

ACTIVE STUDENTS (ENROLLED OR ON-LEAVE) S'07: 10

Jason Boatwright	on-leave
Cathy Buck	enrolled (graduated S'07)
Emily Elasky	informal concurrent MIT/current, on-leave
Royce Hale	enrolled
Kati Halmos	on-leave
Kathleen Henson	enrolled
Glen MacMaster	enrolled (graduated S'07)
Casey Ralston	on-leave
Nellie Tsai	informal concurrent MIT/graduated, on-leave
Yana Radenska	informal concurrent MIT/current, on-leave

SUMMARY 1997-2007

Total # students served = 59
Total # admitted = 48
Total # graduated = 38
Total # left program without graduating = 7
Total # current students (Summer 2007) = 14

% Female = 61%
% Male = 39%
% Ethnic minority = 11.8%

PROFILE OF AVERAGE MSBT STUDENT
% K-12 teachers = 68.1%
% Higher ed teachers = 8.5%
% Informal science educators = 23.4%
Average age = Late 30's (estimate)
Average time to completion = 4.1 years
% Received one quarter RA support = 34%
% Enrolled part time = 60%
% Non residents = 8.5%

AFTER GRADUATION:
% Enrolled in or completed doctoral programs = 10.5%
% Currently employed in education-related fields = 84.2%
% Contacted (Summer 2007) = 94.7%

Appendix D. MSBT Steering Committee, 9/07

Joseph F Ammirati
Department of Biology, College of Arts and Sciences
Mycology, taxonomy and ecology of fungi

P. Dee Boersma
Department of Biology, College of Arts and Sciences
Conservation biology; seabirds as indicators of environmental change.

Thomas M. Hinckley
College of Forest Resources
Forest tree physiology and autecology, subalpine ecosystems, water stress problems

Charles D Laird
Department of Biology, College of Arts and Sciences
cell and developmental biology, human genetics

John M. Marzluff
College of Forest Resources
Behavior, ecology, and conservation of birds and mammals.

Maynard V. Olson
Department of Genome Sciences, College of Medicine
Large-scale genome analysis, molecular evolution, human genetic variation

Carol Hopkins Sibley
Department of Genome Sciences, College of Medicine
Molecular parasitology and drug resistance

Douglas G. Sprugel (Chair)
College of Forest Resources
Community and ecosystem ecology, paleoecology, restoration ecology

Elizabeth Van Volkenburgh
Department of Biology, College of Arts and Sciences
Leaf growth and development, photobiology and electrophysiology

Barbara Wakimoto
Department of Biology, College of Arts and Sciences
Developmental genetics, gene expression and chromosome organization in eukaryotes

Mark A Windschitl
Department of Curriculum and Instruction, College of Education
Science education

Appendix E. Placement of graduates

MSBT GRADUATES 1997-2007

Graduate/year	Email contact	Current employment
Blood, Alicia McComas 2004	amccomas@u.washington.edu alicia_mccomas@hotmail.com ablood@seattleymca.org	Youth development director, YMCA Earth Service Corps, Seattle
Buck, Cathy 2007	catbuck77@yahoo.com	7th grade science teacher, Tolt MS, Carnation, WA
Canino, Nancy 1997	Nancy.Canino@lakesideschool.org	Science dept. head, Lakeside MS, Seattle
Chowning, Jeanne 2004	jchowning@nwabr.org	Education director, Northwest Association Biomedical Research, Seattle
Comisky (Monahan), Lisa 1999	lmonahan@methow.org lisacomiskey@yahoo.com	HS Biology/Chemistry teacher, Winthrop, WA
Cooksley, Elise 2006	enc4@u.washington.edu	HS Biology Teacher, Two Rivers School, North Bend, WA
D'Amore, Judy 2000	jdamore@ptmsc.org	Education director, Port Townsend Marine Science Center, WA
Daughters (Auld), Susan 2001		HS Biology, Squalicum HS, WA (last contact 2003)
Doyle, James (Jed) 2003	jeddoyle@mhs.k12.il.us	Biology teacher, Mundelein HS, Illinois
Frame, Sara 2007	mitzli@rocketmail.com frames@u.washington.edu	Envir. Ed instructor, Costa Rica
Goodwin, Debbie 2004	goodwinds@gmail.com goodwind@u.washington.edu	PhD student, Oceanography, UNH Marine Program
Hall, Kathy 2005	hallka@u.washington.edu	PhD student, Biology/Education, UW

Heins, Donald 1998	dheins@bcc.ctc.edu	Biology faculty, Bellevue Community College
Hoselton, Riley 2000	rhoselton@nursingabc.com	HS Biology teacher, on-line program for nursing students, www.NursingABC.com
Ianni, Cara 2003	clianni@u.washington.edu	Stilly-Snohomish Fisheries Enhancement Task Force, Education Program Coordinator, Everett
Jones, Oliver 2007	obj@u.washington.edu oliverbondjones@gmail.com	HS Biology teacher, Lindbergh HS, Kent, WA
Krell, Tim 1998	tkrell@bellevuechristian.org	Principal, Junior High, Bellevue Christian School
Kwan, James 1998		Unable to make contact.
Larner, Stephen 2000	sflarner@u.washington.edu	PhD, Neuroscience, U. Florida 2004. Center for Traumatic Brain Injury Studies, Department of Neuroscience, McKnight Brain Institute of the University of Florida, Gainesville, Florida
Lutz, Jennifer 1998	lutzj@bsd405.org	HS biology teacher, Bellevue SD. Teaches honors biology, AP environmental science
Mantel (Raley), Veronica 2003	v_raley@jsrhs.net	Science teacher at John Stark Regional HS, NH
Mathews, Alyssa 2007	alyssamathews@gmail.com	Recent graduate, unemployed
McDonald, Tom 2005	tiburon@u.washington.edu mcbell@seanet.com	Environmental Educator/Owner, Tropical Adventurers in Education
MacMaster, Glen 2007	nelgus@u.washington.edu	Biology teacher, Mills HS, Millbrae CA

Mehn, Jack 1999	jmehn@wwps.org	Teacher, Dean of students, Walla Walla HS, WA
Moffat, John 2006	JMoffat@sccd.ctc.edu	Instructor, Seattle Central Community College
Monahan, William 2002	WMonahan@lkwash.wednet.edu, wmmonahan44@aol.com, wrm2@u.washington.edu	HS Biology Teacher, Eastlake HS, Sammamish, WA
Neel, Heather 2006	neel_heather@hotmail.com	3rd grade teacher, Serene Lake Elem., Mukilteo, WA
Olsovsky, Claire 1998	olsovskyc@edmonds.wednet.edu	Safety Officer, Edmonds School District. No contact since 2000.
Oxnard, Nathan 2006	n_oxnard@yahoo.com noxnard@u.washington.edu	Returned to New Hampshire, teaching 8th grade science
Ready, Danica 2000	danicar@u.washington.edu	Development Director, Methow Valley Sport Trails Association
Robles, Brian 2002	roblesb@issaquah.wednet.edu	HS Biology Teacher, Issaquah HS, WA. Selected for SEP at FHCR 2006
Rogers, Michelle 2004	mrog.mrog@gmail.com	Online Adjunct Instructor Davenport University, Ashford University. Education Consultant with UNESCO, Sejours Abroad programs, France. Currently completing EdD.
Strachan, Martha 2003	strachan@myuw.net	Biology teacher, Chair, science department, Meadowdale HS, Edmonds
Todd, Jennifer 2007	jbtodd@u.washington.edu	Recent graduate, unemployed
Updegrave, Cynthia 2007	cupdegra@u.washington.edu	Instructor Community Environment and Planning Program (CEPP), UW

Wakefield (Tanas), Jamie 2003	jamiew2@u.washington.edu jamiewakefield40@hotmail.com	HS Biology, Mountlake Terrace HS, Mountake Terrace, WA (2003)
Wigren, Carl 1997		Unable to make contact

Appendix G. Abbreviated Faculty Curriculum Vitae

DOUGLAS G. SPRUGEL

College of Forest Resources
Box 352100
University of Washington
Seattle, WA 98195

Telephones: (206) 543-2040 (office); (206) 365-8742 (home)
email: sprugel@u.washington.edu

Educational background

Duke University (B. S. 1969, magna cum laude with Honors in Botany)

Yale University (M. Phil. 1971, Ph. D. in Forest Ecology, 1974)

Employment history

1966: Duke University. Pollen slide preparation for D. A. Livingstone.
1967: Museum of Northern Arizona. Bryophyte collecting.
1968: Medicine Bow Mts., Wyoming. Alpine ecology research for W. D. Billings.
1973-74: Department of Biology, University of Pennsylvania (Lecturer).
1974-79: Radiological and Environmental Research Division, Argonne National Laboratory (Postdoctoral Appointee, 1974-76; Asst. Ecologist, 1976-79)
1979-82: Department of Forestry, Michigan State University (Asst. Professor).
1983--: College of Forest Resources, University of Washington (Senior Research Associate 1983-87; Research Associate Professor 1987-1990; Professor (w/o tenure), 1990--)

Honors and Awards

George Mercer Award, Ecological Society of America, 1977
Wilson Memorial Lecture, Miami University, 1982

Professional Societies and Offices Held

Ecological Society of America
- Board of Editors 1978-82
- Nominations Committee 1981
- Historical Records Committee 1982-1988; Chair 1993-1999
- Vice Chair, Vegetation Section, 1988-89
- Chair, Vegetation Section, 1989-90

International Association for Vegetation Science
- Secretary, North American Section, 1985-1989

Research Interests: role and consequences of disturbance in natural ecosystems scaling physiological process from shoot level to stand level; shoot geometry; effect of crown and canopy architecture on productivity;; branch autonomy; paleoecology; restoration ecology.

Other Scientific and Professional Activities (selected)

USDA National Research Initiative Competitive Grants Program, Forest/Range/Crop Ecosystems Program Panel (May 1995)

USDA National Research Initiative Competitive Grants Program, Ecosystem Science Panel (April 2000)

USDA National Research Initiative Competitive Grants Program, Managed Ecosystems Program (Panel Manager) (2001-2002)

NSF Graduate Research Fellowship Program Panel (February 2006)

Fellowships and Grants (selected)

1969-72 NSF Graduate Fellowship

1985-87 Autotrophic Respiration in Forest Stands. (D. G. Sprugel, K. A. Vogt, T. M. Hinckley, and C. C. Grier). National Science Foundation. 2 years, $199,932.

1986-89 Tree Branches: the Link Between Physiological Processes and Intraspecific Competition. (D. G. Sprugel, E. D. Ford and T. M. Hinckley). USDA Competitive Grants Program. 2 years, $150,000.

1987-90 Whole-tree Growth and Development as a Function of Ozone Stress. (D. Wang, T. M. Hinckley, E. D. Ford, D. G. Sprugel, and K. A. Vogt). U. S. Environmental Protection Agency. 3 years, $285,000.

1990-91 Testing a Model of Light Saturation and Temperature Response of Trees. (D. G. Sprugel and R. Ceulemans, joint PI's). NATO International Scientific Exchange Program. 1 year, $4800.

1990-93 Acclimation to Changing Light Environments in an *Abies amabilis* Canopy. (D. G. Sprugel and T. M. Hinckley). USDA Competitive Grants Program. 2.5 years, $160,000.

1992-94 Physiological Scaling with Pacific Silver Fir. (T. M. Hinckley and D. G. Sprugel). U. S. Environmental Protection Agency.) 2 years, $145,000.

1996-99 Optimizing Photosynthetic Capacity in Conifer Canopies: the Role of Shoot Geometry, Leaf Morphology, and Nitrogen Concentration. (D. G. Sprugel, B. A. Yoder (Bond), and T. M. Hinckley). National Science Foundation. 3 years, $204,503.

1999-2004 Late-Holocene Disturbance Regimes in Forests of the Puget Sound Basin: Is Douglas-Fir Dominance an Artifact? (L. B. Brubaker and D. G. Sprugel). National Science Foundation. 4 years, $250,000.

Publications (selected)

Sprugel, D. G. Natural disturbance and ecosystem responses in wave-regenerated *Abies balsamea* forests. Ph. D. dissertation, Yale University, 1974. 287 pp.

Sprugel, D. G. 1976. Dynamic structure of wave-regenerated *Abies balsamea* (L.) Mill. forests in the northeastern United States. *J. Ecol.* 64:889-911.

Sprugel, D. G., and F. H. Bormann. 1981. Natural disturbance and the steady-state in high-altitude balsam fir forests. *Science* 211:390-393.

Sprugel, D. G. 1984. Density, biomass, productivity, and nutrient cycling changes during stand development in wave-regenerated balsam fir forests. *Ecol. Monogr.* 54:165-186.

Sprugel, D. G. 1985. Natural disturbance and ecosystem energetics. Pp. 335-352 *in* S. T. A. Pickett and P. S. White, eds. *The Ecology of Natural Disturbance and Patch Dynamics.* Academic Press, New York.

Sprugel, D. G. 1985. Changes in biomass components through the disturbance cycle in wave-regenerated balsam fir forests. *Can. J. For. Res.* 16:269-278.

Sprugel, D. G. 1989. The relationship of evergreenness, crown architecture, and leaf size. *Amer. Nat.* 133:465-479.

Sprugel, D. G. 1991. Disturbance, equilibrium, and environmental variability: what is "natural" vegetation in a changing environment? *Biol. Conserv.* 58:1-18.

Sprugel, D. G., T. M. Hinckley, and W. Schaap. 1991. The theory and practice of branch autonomy. *Ann. Rev. Ecol. Syst.* 22:309-334.

Sprugel, D. G., M. G. Ryan, J. R. Brooks, K. A. Vogt, and T. A. Martin. 1995. Respiration from the organ level to the stand. Pp. 255-299 in W. K. Smith and T. M. Hinckley, eds. *Resource Physiology of Conifers*: *Acquisition, Allocation and Utilization*. Academic Press, San Diego.

Sprugel, D. G., J. R. Brooks, and T. M. Hinckley. 1996. Effect of light on shoot geometry and needle morphology in *Abies amabilis*. *Tree Physiology* 16:91-98.

Stenberg, P., S. Palmroth, B. J. Bond, D. G. Sprugel, and H. Smolander. 2001. Shoot structure and photosynthetic efficiency along the light gradient in a Scots pine canopy. *Tree Physiology* 21:805-814.

Sprugel, D. G. 2002. When branch autonomy fails: Milton's law of resource availability and allocation. *Tree Physiology* 22:1119-1124.

Brooks, J. R., D. G. Sprugel, and M. G. Ryan, eds. 2002. *Linking the Complexity of Forest Canopies to Ecosystem and Landscape Function. Tree Physiology* 22 (15-16*).* Heron Publishing, Victoria, Canada.

Higuera, P. E., D. G. Sprugel, and L. B. Brubaker. 2005. Reconstructing fire regimes with charcoal from small-hollow sediments: a calibration with tree-ring records of fire. *The Holocene* 15:238-251

HELEN A. BUTTEMER

Director, Biology Programs for Teachers

Senior Lecturer

Department of Biology
University of Washington, Seattle, WA 98195

Education:

Bishop's University, Quebec, CANADA	B.Sc. in Biology, 1972
Simon Fraser University, B.C., CANADA	B.C. (Permanent), 1976
Center for Health Training, CA	Natural Family Planning Teacher Certification, 1982
OSPI	Washington K-12 Teacher Certification, 1984
University of Washington, Seattle WA	M.S. in Biology for Teachers, 1987

Employment:
University of Washington Department of Biology Program Director Biology Programs for Teachers (1985-present), Graduate Adviser M.S. Program in Biology for Teachers (1985-present); Senior Lecturer (1990-present), Program Organizer, Biology Teacher Outreach HHMI UW Science Education Programs (1990-present): Science Teacher, Lakeside Middle School (1988-1994); Program Head, Natural Family Planning, Arcadia Women's Clinic, Seattle (1977-1985); Preschool Director (1979-1983), Seattle; Medical Assistant (1976-1979), Seattle; K-12 Teacher, Seattle (1976-78), Research Technologist, Wellesley Hospital, Toronto, CA (1972-1974)

Honors:
Simon Fraser Open Scholarship (1976); Bell-Asbestos Bursary for Academic Achievement, (1971); The Arnold N. Schock Prize in Biology (1969)

Professional Organizations:
National Association of Biology Teachers, National Science Teachers Association, Washington Science Teachers Association, Association of Professional Advisers and Counselors, Puget Sound Science Supervisors

Professional Activities:

Workshop Presentations / Lectures (selected):

Microbes in the Classroom, HHMI Workshop for MS teachers, campus, 2007
LEAP Summit workshop, UW campus, 2006
Insect Workshop for MS teachers, UW campus, 2006
Inquiry Workshop for Cascade Elementary teachers, UW campus, 2006
Animals 2X2 Teacher Workshop, Lakewood SD, 2005
North Cascades & Olympic Science Partnership, workshop, UW campus, 2005
Outward Bounds, Expeditionary Learning workshop, Seattle, 2003
UW Pipeline, Inquiry workshop, campus, 2004, 2005
Contextual Teaching & Learning for Indonesian Educators, UW Campus, 2002
Inquiry for National Institute Education Educators from Singapore, UW Campus, 2002
Teacher Learning Partnership workshop, UW College Education, 2002

National Association Biology Teachers, National Convention, K-12 paper 2001, workshop 2003
National Science Teachers Convention, K-12 workshop, 1991, 1998, 2004
Washington Science Teachers Convention, K-12 workshop, 1990, 1992, 1997, 1999
QuEST, Outreach Education, 1997
UW Teacher Education Program, EDTEP 587, 1997, 1998, 1999, 2000, 2001, 2002, 2003
Washington Association for Biomedical Research, K-12 workshop, 1997
American Association for Advancement of Science, Poster, Seattle, 1997
UW Botany 502, TA Training, 1996, 97, 98, 2000, 2001
UW Biology Career Day, 1989-00
UW K-12 Outreach Education Group, 1995, 1997.
Student Washington Education Association, 1995.
Making Connections Summer Institute for Teachers, UW, 1994.
Workshop Presentations / Lectures continued (selected):
Student Washington Education Association, 1995.
Making Connections Summer Institute for Teacher ,UW, 1994.
Seattle School District, 3 Workshops, 1992.
Earth Day Celebration, Seattle, 1990.

Workshop Coordinator:
Director, HHMI/UW Biology Teacher Outreach Program (Summer Institute for Life Science, Quarter Institute Life Science, Saturday Science, Teacher Leadership Institute), 1990-present
Wind River canopy Crane workshop, 2005, 2006
Olympic Park Institute workshop, 2004
Inquiry Workshop, Highline School District, Jan. 2002
Blood & Guts: Human Anatomy for Elementary Teachers, Nov. 2000
Alpine Wetlands for Teachers, UW 1997, 1998.
Science Enhancement for Teachers (Biology), UW, 1989-94.
High School Biology Curriculum Committee, UW, 1988.

Consultant / committee work:
Integrated Science Committee, proposal new major, UW A&S, 2006-2007
Curriculum review, Woodland Park Zoo, 2006
Curriculum review, FacingtheFuture.org, 2007
Search Committee, Director K-12 Institute, UW College Education, 2004-2005
Teachers for a New Era, UW, 2003-present
Middle School Systemic Science Partnership, 2002-present
Expeditionary Learning, Outward Bound, 2003
Strengthening and Sustaining Teachers Committee, UW, 2000-01
AIBS/Packard HS Biology Textbook Review Committee, 1999-2001
NABT Outstanding Biology Teacher Award Committee, 1998, 1999
Genetics Education Partnership, 1998
Office of Superintendent of Public Education, Biology Endorsement Committee, 1998, 2001
Native American Science Outreach Network, UW Chemistry, 1997-99
Environmental Health for Middle School Teachers, UW, 1996-99

K-12 Science Outreach (selected):
Inquiry Workshop for Southridge HS students, UW campus, 2006
Volunteer Scientist, Bryant Elementary School, 10-weeks 2002
Science Fair Judge, Chinook MS, May 2000
Lakeside Biology Assessment Panel, 1996-01

Seattle Area Schools, guest lectures, consultation, 1985-present.
Summit K-12 School, Seattle, WA., Semester Courses in Secondary Biology, 1984,1993.
City School, Vancouver, B.C., Secondary Biology, 1973-74.

Publications:

Buttemer, H., Inquiry On Board, Science & Children, Oct. 2006
Morse, M.P. and AIBS Review Team, A Review of Biological Instructional Materials for Secondary Schools, American Institute of Biological Sciences, March 2001.
Windschitl, M and H. Buttemer: What Should the Inquiry Experience be for the Learner? The American Biology Teacher, May 2000.
Windschitl, M and H. Buttemer, Beyond the Process Skills: What Should the Inquiry Experience be for the Learner, Essays on Content and Pedagogy, UW College of Education, Spring 1999.
Buttemer, H. 1990. National Sharing Conference in Human Genetics Meets Needs of Educators and Genetic Counselors Alike. Genetics Northwest, 5 (4), 10.
Van Lier, J.E., Kan, G., Buttemer, H. 1971. Cholesterol Autoxidation: 26-Hydroperoxycholesterol. Proc. Can. Fed. Biol. Soc. 14, 367.

Appendix H. HEC Board summary

Name of unit authorized to offer degree: Biology Teaching Group

School or College: Graduate School

Exact title of degree offered: Master of Science in Biology for Teachers

Year of last review: 1998

Brief description of the field and its history at UW:

The UW Mission Statement states "*We promote access to excellence and strive to inspire through education that emphasizes the power of discovery and the foundation of critical and analytic thinking*." The Master of Science in Biology for Teachers (MSBT) program supports this goal by providing high-school teachers access to the University's faculty and letting them participate in the process of discovery by carrying out an independent research project in a University research lab under the supervision of a professional scientist. The expectation is that the experience these teachers gain through these projects will make them better able to help their own students understand the excitement of discovery and how science is really done, rather than how it is presented in textbooks.

The MSBT has changed little since it was first proposed in 1967. Students take up to 30 credits of course work in a variety of fields, but the core of the MSBT program is the research project. While not as detailed or involved as a full-fledged Master's thesis, the research project is expected to involve all the basics of scientific investigation: formulating a hypothesis, collecting and analyzing data, testing the hypothesis, drawing conclusions, and presenting the results in both written and oral formats. The study takes approximately one quarter of full-time work (or an equivalent amount of time spread out over a longer period) and concludes with a written report, prepared as if for publication, and an oral presentation to a committee of MSBT faculty.

One of the strongest aspects of the MSBT program is its flexibility. Students may take courses in any department to fulfill broad subject-area requirements, which allows even full-time teachers to put together meaningful programs that meet their interests and their needs as teachers, and at the same time fit with their often demanding work schedules. For the project, students may work with any University faculty member and are responsible for working out an appropriate topic with him or her.

Documentation of continuing need for the program

Since the MSBT program was begun in 1967, discovery- or inquiry-based education has become increasingly central to American science teaching. There are few graduate programs in the country that provide biology teachers the opportunity to carry out a significant research program of their own, and none in Washington. The continuing and increasing flow of applicants suggests that the need for such a program has become greater, not smaller, over the past 40 years.

Assessment information

In a recent survey of students who have graduated from the program in the past 10 years, responding students stated almost without exception that the program had a positive impact on

their professional careers, improving their teaching skills allowing them to do things they would not have been able to do without the degree.

Graduation grid

Year	2005	2006	2007
Number of undergraduate majors graduating from the unit	0	0	0
Number of master's degrees granted	3	4	7
Number of doctoral degrees granted	0	0	0

Goals for the future

The overall goal for this program is and has always been to prepare our students to be effective science teachers in the 21st century. Although we do not have a formal procedure for setting and updating goals, the Steering Committee meets annually to monitor program activities and discuss future directions. A survey of faculty members who have recently supervised MSBT student research projects suggested that communication between the program and faculty advisors needs to be improved, and we will take specific steps to do that.

The program has been growing slowly over the past decade, and we feel it has now reached a size that is appropriate to its clientele and function. Further program growth could probably be achieved by publicizing the program more widely, but would be difficult to administer without significant increases in resources.

Appendix I. Recent MSBT students, projects, and advisers

Alicia Blood

Project: Correlates of Migratory Behavior in Gambel's White-Crowned Sparrows. 2004.
Committee chair: Marilyn Ramenofsky, Biology. mramenof@u.washington.edu

Cathy Buck

Project: Effects of Flooding on *Buddeleja* and *Populus* saplings on sandbars in the Tolt River, Washington. 2007
Committee chair: Tom Hinckley, Forest Resources hinckley@u.washington.edu

Jeannie Ting Chowning

Project: SIV Envelope Variation and the development of Neutralizing Antibodies. 2004.
Committee chair: Nancy Haigwood, Pathobiology, Microbiology. haigwood@u.washington.edu

Elise Cooksley

Project: A Comparison of Morphological and Physiological Differences in the Sun and Shade Forms of *Gaultheria shallon*. 2006.
Committee chair: David Ford, Forest Resources. edford@u.washington.edu

Susan Daughters

Project: How Cola Consumption Affects the Bone Mineral Density in Teenage Girls. 2001.
Committee chair: Susan Ott, Medicine. smott@u.washington.edu

James Doyle

Project: Identification of Natural sequence Variation of a Candidate Gene for Bitter Taste Reception, TAS2R1. 2003.
Committee chair: Debbie Nickerson, Genome Sciences. debnick@u.washington.edu

Sara Frame

Project: Eel Grass Dynamics: Natural and Anthropogenic Disturbances in the South Puget Sound. 2007.
Committee chair: Jennifer Ruesink, Biology. ruesink@u.washington.edu

Deborah Goodwin

Project: Remote Sensing in the Nearshore: Quickbird Imagery in South Puget Sound. 2004.
Committee chair: Miles Logsdon, Oceanography. mlog@u.washington.edu

Katherine Hall

Project: Phylogenetic and Geographic Relationships of Two Allopatric Species of Jumping Mice. 2005.
Committee chair: James Kenagy, Biology. kenagy@u.washington.edu

Cara Ianni

Project: Birds on Loan: Measuring the Extinction Debt of Urbanization. 2003.

Committee chair: John Marzluff, Forest Resources corvid@u.washington.edu

Oliver Jones

Project: New Species and New Life History traits Discovered in Isolates of Microorganisms Cultured from the Black Sea. 2007.
Committee chair: James Staley, Microbiology. jtstaley@u.washington.edu

Veronica Mantel

Project: An Investigation in DNA Binding: the Genetic Screening of a Library of Mutants of the Homing Endonuclease I-Ppol. 2003.
Committee chair: Ray Monnat, Pathology, Genome Sciences. monnat@u.washington.edu

Alyssa Matthews.

Project: Mate recognition in Zebrafish. 2007.
Committee chair: Dave Parichy, Biology. dparichy@u.washington.edu

Thomas McDonald

Project: A Comparison of Biodiversity in the Understory of Two Monoculture Plantations in Southwestern Costa Rica. 2005.
Committee chair: Robert Gara, Forest Resources garar@u.washington.edu

John Moffatt

Project: Endocrine and Morphological Responses to Prolonged Migratory Restlessness in Gambel's White-Crowned Sparrows. 2006.
Committee chair: Marilyn Ramenofsky, Biology. mramenof@u.washington.edu

William Monahan

Project: Insertion of Green Fluorescent Protein and Red Fluorescent Protein Genes into CB1 Receptors to Facilitate Internalization Studies. 2002.
Committee chair: Kenneth Mackie, now at Indiana University

Heather Neel

Project: Correlation Between Skin Ulcers and Distribution of Ichthyophonus Spores in the Skeletal Muscle of Pacific Herring, Clupea pallasi. 2006.
Committee chair: Richard Kocan, Fisheries. kocan@u.washington.edu

Nathan Oxnard

Project: Coordination of Nuclear and Cytoskeletal Events in the Drosophila Blastoderm Cycles. 2006.
Committee chair: Gerold Schubiger, Biology . gerold@u.washington.edu

Bryan Robles

Project: Enhanced Translocation of rCB1 in HEK Cells by Insertion of a Preprolactin Signal Sequence. 2002.
Committee chair: Kenneth Mackie, now at Indiana University

Michelle Rogers

Project: Molt Migration Behavior of the Ash-Throated Flycatcher, Myiarchus cinerascens. 2005.
Committee chair: Sievert Rohwer, Biology. rohwer@u.washington.edu

Martha Strachan

Project: In-Vitro Characterization of Astrocytes and Implications for Cannabinoid Use in Disease. 2003.
Committee chair: Nephi Stella, Pharmacology, Psychiatry & Behavioral Sciences. nstella@u.washington.edu

Jennifer Todd

Project: Analysis of proportions in anterior dentition of macaque monkeys. 2007.
Committee chair: Patricia Kramer. Anthropology. pakramer@u.washington.edu

Cynthia Updegrave

Project: 100 years of history of Duwamish River. 2007.
Committee chair: Estella Leopold, Biology. eleopold@u.washington.edu

Jamie Wakefield

Project: Cloning of the Rat Insulin Receptor Substrate -2 cDNA. 2003.
Committee chair: Robert Steiner, Obstetrics & Gynecology, Physiology & Biophysics. steiner@u.washington.edu

Appendix J. Responses to faculty questionnaire (sent to all faculty who have supervised an MSBT student within the past 5 years)

E. David Ford
College of Forest Resources

Based on your experience supervising Elise Cooksley's project,

1. Why did you agree to supervise an MSBT student project?

Faculty responsibility. And I am adjunct in Biology.

2. Was the outcome of the project satisfactory from your perspective?

Yes. She learnt a lot.

3. What, if any, changes could be made to the MSBT program to make it better from the perspective of a student advisor?

An earlier identification of what the project might be. Then more reading could be done and a better identification made of the scientific question.

Robert L. Gara
College of Forest Resources

Based on your experience supervising Tom McDonald's project,

1. Why did you agree to supervise an MSBT student project?

I have known Tom for several yrs and he would be a self-driven and serious MSBT student

2. Was the outcome of the project satisfactory from your perspective?

yes

3. What, if any, changes could be made to the MSBT program to make it better from the perspective of a student advisor?

I wouldn't change anything as my experience with the program was entirely satisfactory

Nancy Haigwood
Department of Pathobiology, School of Public Health and Community Medicine

1. Why did you agree to supervise an MSBT student project?

I knew Ms. Chowning from working with her at NWABR (formerly WABR), and I knew of her talents and dedication to science, so it seemed like a great fit, as we have some fun, relevant science going on in the lab.

2. Was the outcome of the project satisfactory from your perspective?

Jeanne did an excellent job in the lab, and her report (thesis) was well written. I was happy with the interactions, which were different from a lab-based graduate Ph.D. Student but not terribly different from an M.S. Student in the lab sciences.

3. What, if any, changes could be made to the MSBT program to make it better from the perspective of a student advisor?

It would be helpful to have a clearer message about expectations for the projects. We gave her a project that could be completed in the allotted time, but that is not realistic for a lab project, which can take 1-2 years of solid work to make progress on. It worked to assign her to work with another graduate student (Ph.D. Student) to make progress on that project.

G. James Kenagy
Department of Biology and Burke Museum

Based on your experience supervising Kathy Hall's project,

1. Why did you agree to supervise an MSBT student project?

Very simply because she was a student who did well in a class i was teaching. Thus it followed easily just to make the personal commitment, because i knew her already. It has nothing to do with the MSBT program per se.

2. Was the outcome of the project satisfactory from your perspective?

In absolute terms this is hard to say; the research experience is so modest compared to typical ms-thesis research, something of a "demonstration project" in which the student does not really master the skills, but simply reports an experience. As such, I would say it was successful.

3. What, if any, changes could be made to the MSBT program to make it better from the perspective of a student advisor?

Not sure; as I have not been asked to change to goals and scope of the program. It is what it is, but should it be more??

Richard M. Kocan
Aquatic and Fisheries Sciences

Dear Doug:

My response follows each of your questions. I think this is a very useful program and hope it continues. I'm glad I had the opportunity to participate and contribute.

1. Why did you agree to supervise an MSBT student project?

Response: I feel that the earlier a student is introduced to science the better equipped they will be to deal with science curricula in the future. The MSBT experience offers teachers hands-on experience for solving real science problems, thus making it easier to convey this concept to primary and secondary grade students. In summary, it removes science from the textbook and puts it in the real world of problem solving.

2. Was the outcome of the project satisfactory from your perspective?

Response: Absolutely. Heather's project actually answered some valid scientific questions. We have subsequently continued the project and expect that the data will be published in a peer reviewed science journal with Heather as the senior author.

3. What, if any, changes could be made to the MSBT program to make it better from the perspective of a student advisor?

Response: Having the student for a longer block of time would have been helpful. Some projects just do not lend themselves to short periods of effort followed by weeks or months of down-time. This may not apply to all projects, but is was a consideration with the type of work we do in our laboratory.

Sincerely,

Richard M. Kocan, Ph.D.
Professor Emeritus
Fisheries & Aquatic Sciences

Miles Logsdon, Ph.D.
Department of Ocean and Fishery Sciences, School of Oceanography

Based on your experience supervising Deborah Goodwin's project,

1. Why did you agree to supervise an MSBT student project?

I agreed to supervise Deborah Goodwin's project primarily because of Deb's excitement when she proposed the project to me. Deb had a clear idea of her overall goal of extending the principles we use in making estimates of productivity from marine grasses from satellite base remotely sensed measurements to High School level science curriculum. She saw great potential in combining teaching opportunities in biology, physics, math and computers from this one applied task. The issues of her project really were issues of data and how established

methods for making these estimates often fail due to a wide range of natural conditions. She not only learned a lot herself, but taught many of us involved with her project just how often we overlook some of these data failures. In short, I agreed to work with Deb most because of her only excitement for the project and knowing that I would not have to work on motivating her to do good work.

2. Was the outcome of the project satisfactory from your perspective?

Yes. Not only do I feel that she produce a good project, she also provide my lab with many excellent data products which I have used in teaching my own introductory class here on campus. From my perspective, the project was satisfactory because Deb was pleased with what she did. I would not want to suggest that her project would have been considered an outstanding project in the specific field of biological oceanography and ocean optics, but that was not her objective. I was very happy with the outcome of her work.

3. What, if any, changes could be made to the MSBT program to make it better from the perspective of a student advisor?

As an advisor, the only contact I had with others advisors of MSBT graduate projects was from the "stories" Deb would tell me of what other students were doing. I often asked her "what was the scope of other project"? I also, never meet in person with MSBT program managers until the final week of her project. I would hope that some form of orientation might now exist or be considered for future MSBT graduate students and their advisors.

Miles Logsdon, Ph.D.
Walters Assistant Professor of Ocean and Fishery Sciences
University of Washington, School of Oceanography

Ken Mackie, MD
Dept. of Psychological & Brain Sciences, Indiana University

Based on your experience supervising William Monahan and Bryan Robles' projects,

1. Why did you agree to supervise MSBT student projects?

I think it's important that the MSBT students get exposure to an active research laboratory. This provides first hand experience with a variety of laboratory techniques as well as gives an up front view of a few of the questions being studied. I think this is very valuable if they will be teaching kids that might be going into the sciences.

2. Was the outcome of the projects satisfactory from your perspective?

Yes. Both Bill and Bryan worked hard and completed their projects, while learning quite a bit along the way.

3. What, if any, changes could be made to the MSBT program to make it better from the perspective of a student advisor?

No particular changes. Early matching of student and advisor is always helpful.

Ken Mackie, MD
Linda and Jack Gill Chair of Neuroscience and Professor
Dept. of Psychological & Brain Sciences
Indiana University

John Marzluff
College of Forest Resources

Based on your experience supervising Cara Ianni's project,

1. Why did you agree to supervise an MSBT student project?

Cara had taken several of my classes and had worked as a technician on my songbird research project. So, I knew her well and knew she was keenly interested in conducting her own research. When she received funding for her MSBT program, I eagerly accepted her into my lab. She participated in all by lab activities (seminars, lab meetings, research discussion, etc) and was a very independent and driven student.

2. Was the outcome of the project satisfactory from your perspective?

Absolutely. Cara was a fine student and a skilled educator. She added a novel dimension (education) to my lab group and was as competent as any student in the field. She worked hard to design and establish her independent research track that meshed well with the others in my lab. Her thesis was excellent and, if I can carve out a bit of time this summer, we will publish it. Cara and I are still in touch and I am pleased with her professional work as a MSBT graduate. She is remaining productive and meaningful to the natural resources (especially salmon and riparian habitat) in the Monroe/Snohomish area.

3. What, if any, changes could be made to the MSBT program to make it better from the perspective of a student advisor?

I would like to see all the projects involve an independent research component. This would make the theses produced valuable and the skills of the graduate more diversified. They are all good communicators and educators, but I would like to see them with a real and meaningful research experience that they can take to the next job or classroom.

Susan M. Ott, MD
School of Medicine

Hello,

I agreed to supervise one student because I was submitting a grant at the time, which would have involved the MSBT program, and Helen asked if I would supervise one of her students who was interested in bone problems. I thought this went well, she received her degree, was exposed to some epidemiological research, and helped me to evaluate some materials in her classroom.

I have had only one student so I don't really have many other suggestions.

Susan M. Ott, MD
Associate Professor, Medicine

Marilyn Ramenofsky
Department of Biology

[supervised two students]

1. Why did you agree to supervise an MSBT student project?

I enjoy working with students/ teachers at this level. Most that I have directed have been outstanding and dedicated teachers. They applied this great attitude and curiosity to their work in my lab.

2. Was the outcome of the project satisfactory from your perspective?

Absolutely, in most cases the projects were directly related to my research and helped to further my understanding of bird migration. These students were able to pursue projects, which at the time, I didn't have time upon which to focus. But having able and competent students carrying out the experiments allow all concerned to benefit. In many cases the results from these projects were presented either as papers or posters at international meetings.

3. What, if any, changes could be made to the MSBT program to make it better from the perspective of a student advisor?

Time is always a factor with these projects. Students are usually completing a heavy work-load or may have even gone back into teaching. If there is any way that they could get into the lab or started on the projects earlier to allow for more time to identify the projects and conduct the research as well as write-up, this would greatly help and relieve a lot of the pressure that the students feel. I would like to see explicit criteria for formatting the thesis. I usually have the students follow that of published papers but a more uniform construct would benefit both the student and supervisor

Marilyn Ramenofsky
Department of Biology
Laboratory of Environmental Endocrinology and Migration

Sievert Rohwer
Burke Museum,

Hi Doug:

1. I agree to supervise these projects if the students seem serious enough about research to do something publishable.

2. In the sense that it has been accepted for publication in a leading Ornithological journal, yes. But Michelle was pretty hasty and not at all careful in how she did things. Thus I had to have one of my graduate students redo most of the measurements and write up the project. This involved long delays and a huge amount of my time spent convincing Michelle that she could not do this from France. She had entirely too many other things going on to do a good job of her thesis work.

3. I don't have enough experience to respond. In Michelle's case she wanted everything to be formulistic, and I rather doubt that she ever spent enough time thinking about this project to appreciate the nature of research. She needed more time to spend on this work, but I don't know that this is a program problem as much as a Michelle problem. (Years ago I supervised Carol Spaw, and she went on to publish a series of papers from her work and follow-up work, several of which have been heavily cited.)

Sievert Rohwer
Curator of Birds
Burke Museum, Box 353010

Gerold Schubiger
Department of Biology

Based on your experience supervising Nathan Oxnard's project,

1. Why did you agree to supervise an MSBT student project?

He was an excellent student in my Bio 411 course - well organized and efficient - but naïve in terms of what work in a research lab is all about - from the beginning till publication.

2. Was the outcome of the project satisfactory from your perspective?

yes - because he is a co-author on a publication in the journal genetics

3. What, if any, changes could be made to the MSBT program to make it better from the perspective of a student advisor?

More time in a lab where a small group works on the same project.

Gerold Schubiger
Department of Biology
University of Washington

James T. Staley, PhD
Department of Microbiology, School of Medicine

Based on your experience supervising Oliver Jones' project,

1. Why did you agree to supervise an MSBT student project?

Our lab has always been open to working with students at all levels. Oliver was an especially good match for us. He was very interested in the work we were doing and the timing was right for everyone.

2. Was the outcome of the project satisfactory from your perspective?

The outcome was excellent. Oliver's work made an important contribution to our lab's efforts to understand the types and activities of bacteria in the Black Sea.

3. What, if any, changes could be made to the MSBT program to make it better from the perspective of a student advisor?

I am not sure that any changes are necessary. It is true that these arrangements between the student and the supervisor are somewhat random and ad hoc, but I am not sure there is any better mechanism to make such matches that would not entail extra work for all.

I strongly believe that it is important for high school science teachers to have first hand experiences with lab research and to that end, anything that could be done to improve the quality of this effort should be pursued. Unfortunately, money is an issue. On the positive side, NSF and other federal agencies are aware of the need to promote science education so perhaps an effort by UW to pursue this would be fruitful. For example, the NSF IGERT program, might be a source of funding for a science based program for high school teachers pursuing MS degrees. I believe it is an idea worth pursuing.

James T. Staley, PhD
Professor, Microbiology
University of Washington Box 357242

Robert A. Steiner
Departments of Obstetrics & Gynecology and Physiology & Biophysics, School of Medicine

1. Why did you agree to supervise an MSBT student project?

I agreed to supervise Jamie Wakefield's MSBT project because I believe it's vital to have our K-12 biology teachers have first hand knowledge of what science means operationally- the process whereby we come to understand the living world. Science is about doing- more than knowing, and I am personally persuaded that that there is something transformative about actually participating in scientific inquiry. Having our teachers work as scientists at the frontiers

of discovery and contribute something essential to the intellectual and physical journey is a right of passage that can only help our teachers become better educators.

2. Was the outcome of the project satisfactory from your perspective?

Jamie's project was highly successful. She accomplished the specific objectives of the project. She immersed herself into the quotidian life of our research laboratory and became a full member of our tightly-knit corps of discovery. Jamie shared the joy and pride of our successes as well as the frustrations and disappointment of the inevitable setbacks. She learned her lessons well, and we all felt like Jamie was a scientist at work, who would truly be a gift to any class of eager young learners.

3. What, if any, changes could be made to the MSBT program to make it better from the perspective of a student advisor?

From my perspective the MSBT program is one of the jewels of the University of Washington, and I can't think of anything substantive that I'd recommend changing. I think it's worth noting that in most cases, providing a research environment and experience for each of the trainees requires that a laboratory commit significant time and resources ($$) into this training experience. In our case, Jamie was paired with my technician (Dawit Teklemichael) during her training, which was essential for her success. The MSBT program depends not only on laboratory PIs for their contribution but perhaps even more important are the unsung educators in this process- the graduate students, postdocs, and technicians who provide the real hands-on teaching. I think it might be worthwhile to consider how these people- in the trenches, actually doing the science- might be rewarded for their participation in this educational mission. I also think it would be wonderful if there were an opportunity for the trainees to receive financial aid to attend a scientific meeting with their supervisor.

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Robert A. Steiner
Professor of Obstetrics & Gynecology and Physiology & Biophysics
University of Washington

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Appendix K. Responses to survey of MSBT graduates, 1997-2007

CATHY BUCK 2007

1. What are you doing now? Did the MSBT help advance your career?

1.) This year I will return to teaching 7th grade. I am considering other options beyond this year as a result of the masters- I may eventually switch to high school. I also have an offer to teach at a community college. I am ready for some kind of change and I think the master's will help me make that change.

2. How did participating in the MSBT program influence you as a teacher?

2.) Participating in MSBT program influenced me as a teacher in many, many ways: the research process was eye-opening. I experienced firsthand the excitement of discovery, learned about the difficulty of field work and the attention to detail. I was inspired by my UW teachers, learned new activities that will directly benefit my students, improved my technology skills enormously, made connections between topics that help me assemble a bigger picture of life science. But most of all, I now have confidence in what I know is good for kids – I will try to help my school administration understand the importance of hands on, real experimentation, and outdoor science.

3. What were the strongest points of the program and what aspects of the program, if any, do you think could be changed or improved.

3.) The strongest aspect of the program was the flexibility it provided to take classes in many different areas, fill in gaps in my knowledge and to try out whole new areas. There was a large amount of freedom to fit the program to my own individual interests and needs while still maintaining a high standard. The item that was difficult was the flip side to this so to some degree I am not sure it can be remedied-I didn't have any area to fit in so there was a lot of stress in trying to find classes that I could take and would fit together to meet all the requirements. I didn't seem to officially fit anywhere so even when I tried to sign up for biology classes, it would say that the majors had first choice. One way I think to relieve stress and have some sense of fitting or connecting in somewhere would be to have an official orientation meeting scheduled even if it was only for one person. I remember a huge checklist of items that were mystifying to me because I had not been at school in so long and so I ended up doing lots of things the hard way. An informal sort of mentor-a student either recently leaving the program or still in the program would have also been helpful at first just to get my feet under me.

Another huge strength of this program is Helen Buttemer. She is the glue that keeps any of it together. She always had clear straightforward and prompt solutions and ideas when needed that kept things moving.

Another suggestion is to have a short meeting when the research project is chosen between Helen, the student and the advisor to make sure everyone is on the same page about general expectations and timelines etc. I felt pretty lost in that process as to expectations, what the function of the committee was, when and why they were involved, how large of a research project to pursue etc. It all works out in the end but would be less stressful with more clarity along the way.

Overall, I think this is a fantastic program! Unique and very beneficial to teachers and their students.

NANCY CANINO 1997

1. What are you doing now? Did the MSBT help advance your career?

I am a science teacher and the science department head at Lakeside Middle School. The MSBT gave me the credentials to be hired by a top-notch school even though I had very little actual teaching experience (just substitute work that was also obtained through Helen's referral of me to the school that needed a spring-time long-term sub). Lakeside vastly prefers to hire teachers with advanced degrees, and through Helen's help I was able to obtain both my teaching certificate and the MSBT in the same basic program (I had to take a couple of different classes for each). I was originally planning on teaching in public school and am glad to have the certificate (and besides, it forced me to take some very key classes that make me a better teacher). I also get paid a bit more for having my advanced degree. Since I obtained my MSBT at the same time I entered teaching it didn't really advance my career, but it certainly got it off to a great start.

2. How did participating in the MSBT program influence you as a teacher?

I was taking science education classes at the UW at the same time I was taking the MSBT classes and together they created an excellent synergy to make me keenly aware of how to teach science. My science classrooms are full of real science, with students designing experiments and asking lots of questions. I use a lot of inquiry lessons, especially in biology and earth science classes. I got to take Physics by Inquiry as part of my MSBT work and that class was critical in improving my teaching. I also got to fill out my range of science topic classes (including invertebrate zoology and phytology at Friday Harbor Labs) that gave me experiences I have translated into my classroom (I lead an outdoor trip for 7th graders to San Juan Island every spring as a result). My comfort with a classroom in which students are doing science is much higher for having both been a participant in one of those classrooms and for taking classes that helped me learn how to run such a classroom.

3. What were the strongest points of the program and what aspects of the program, if any, do you think could be changed or improved.

The strongest point of the program, from what I can remember, was the flexibility of courses I could take to satisfy the requirements. This allowed me to fill in some important content gaps as well as take some of the classes I needed for my teaching certificate completion. I may have been an oddball case in this regard. I believe that the certificate program at the UW has changed since my time there.

Helen Buttemer is also one of the strong points of the program. Her energy, intelligence, sense of humor, organizational skills and ability to encourage you even when you're feeling wornout (like when it's time to get that thesis done!) are all exceptional -- she makes the MSBT program work for people like me. I was also very impressed with the professors I met through the program, some of whom helped me out as I got started in science teaching by providing me with fruit flies or getting me connected with the agar plate lab folks for supplies for my classroom.

I don't have any particular suggestions for improvement as I don't remember any particular issues that arose as I went through the program. I think it would be great if more folks

knew about the program so I guess I would encourage more marketing of the program, especially to private school teachers who don't hear much about opportunities from the UW and other public schools.

JEANNE CHOWNING 2004

1. What are you doing now? Did the MSBT help advance your career?

1. I'm Education Director for the NW Association for Biomedical Research. I believe having the MS has helped my career and allowed me to be involved in some professional projects that I otherwise may not have.

2. How did participating in the MSBT program influence you as a teacher?

2. I have been able to apply elements of my learning, especially from the education courses, to my work with other teachers.

3. What were the strongest points of the program and what aspects of the program, if any, do you think could be changed or improved.

3. The strongest points were
- *a) The research experience - I think all science teachers should have these!*
- *b) The flexibility to choose coursework in different areas*
- *c) Helen does a great job running this program*

I also really appreciate that this is an MS degree.

I was not able to make any of the get-togethers. I think perhaps a mandatory group meeting each semester might have been nice, to meet our colleagues, learn about our projects, etc.

DEB GOODWIN 2004

1. What are you doing now? Did the MSBT help advance your career?

1. I am currently a PhD student in Oceanography, with a long term interest in a teaching career, ideally at the undergraduate level. Since I completed my MSBT, I have been teaching high school math and science in both formal and informal settings (boarding and public schools, high school semester at sea programs). The MSBT program allowed me to further my academic work in science while maintaining my committment to teaching - in retrospect, I think I would have been better served with a standard MS with more rigorous research requirements, but I was pleased with my experience at the time. I have not remained in Washington state; perhaps I would have taken away a stronger connection to the program had I stayed in the region and connected with the folks I met while part of the MSBT.

2. How did participating in the MSBT program influence you as a teacher?

2. The MSBT program requirements meant that I took graduate level coursework in a wider range of scientific disciplines than I might have selected myself. This allowed me to interact with graduate students and professionals from more departments and increased the resources

available to me as both a student and a teacher. In terms of my teaching skills or experience, I don't think that the program specifically developed those as much as it might have. I was not asked to apply the academic work I was doing to my teaching nor work to integrate my experiences into the classroom.

3. What were the strongest points of the program and what aspects of the program, if any, do you think could be changed or improved.

3. I really appreciated the opportunity to tailor my graduate experience (academic and research together) to my own interests, areas I felt I needed further background in, and topics I wanted to pursue in my teaching. This is truly a strength of the program, along with the fact that it provides the chance for non-scientist teachers to obtain a graduate level experience in these rapidly-developing disciplines. However, the program also feels a bit disjointed as a result - students don't really get the advantage of being part of a department or cohort and there is less camaraderie than in other situations. I felt as though I was merely skimming the surface of subjects that I found interesting - if this is the purpose of the program, it should be better stated to prospective students. I know that I am perhaps more a serious scientist than others in the MSBT, but I might have selected a different program or more thoroughly considered where my time in the MSBT would take me with more information upfront.

RILEY HOSELTON 2000

1. What are you doing now? Did the MSBT help advance your career?

1*. Currently I am teaching high school Biology on-line to potential nursing students who are deficient in this particular science. I am employed through www.NursingABC.com*.

While I work for my undergraduate Chemistry professor who would have hired me even without a masters degree, it was a boon to the program for me to hold a higher degree. They have recently gone through accreditation, and, as you know, the more masters and doctors you have, the more impressive the program looks.

2. How did participating in the MSBT program influence you as a teacher?

3. What were the strongest points of the program and what aspects of the program, if any, do you think could be changed or improved.

2 and 3. Participating in the program provided me with a host of new ideas to bring into the classroom. The greatest strength of the program being the wide range of courses available to choose from. I have used medical ethics scenarios in my high school Bio classes, human physiology projects in my junior high class rooms, and information from neonatal nursing courses during my own pregnancies!

I cannot think of a thing to change; I enjoyed my experience thoroughly.

CARA IANNI 2003

1. What are you doing now? Did the MSBT help advance your career?

1. Currently I work at an organization that performs community-based salmon habitat restoration. In other words, we utilize local citizens and community groups in authentic salmon recovery efforts. I manage the volunteer program (1,400 volunteers per year) and the education program, where K-12 students are involved in a stream restoration project while learning about watersheds, salmon and ecology.

The MSBT program most certainly advanced my career. I think that ALL science teachers should have the opportunity to wear the hat of a scientist, like the MSBT program offers. I was able to learn current concepts, methods and research in ecological science, which enables me to understand stream restoration and engage the public in environmental stewardship. In the program, I also learned more about current pedagogical techniques, such as inquiry-based methods, that I apply in my career.

2. How did participating in the MSBT program influence you as a teacher?

2. Students that I now teach become real scientists: they ask questions, design relevant research, and interpret and communicate their results. The MSBT program gave me the skills to be comfortable and fluid in facilitating these young scientists' inquiries.

3. What were the strongest points of the program and what aspects of the program, if any, do you think could be changed or improved.

3. The strongest point of this program is the research component. Learning from the mistakes and successes of conducting research is invaluable for someone preparing to teach science. I was fortunate to receive two quarters of research-assistantship funding as part of the MSBT program, and this was essential to being able to do my research. I would encourage more funding like this to be available to MSBT students; perhaps they would need to submit a research proposal in order to be ready for, or to earn, the funding.

OLIVER JONES 2007

1. What are you doing now*? teaching high school science*

Did the MSBT help advance your career? *Yes*

2. How did participating in the MSBT program influence you as a teacher?

experience as a lab scientist allowed me to answer the question "yes but how do they know that?"

3. What were the strongest points of the program and what aspects of the program, if any, do you think could be changed or improved.

strong: awesome openness in choosing courses that could help you. project was a totally amazing experience, and the openness allowed me to find my own awesome lab to work in. nothing needs to be improved.

Any additional comments? *this was a rigorous, excellent, entertaining, educational experience. truly one of the greatest things I've ever participated in.*

TIM KRELL 1998

1. What are you doing now? Did the MSBT help advance your career?

I am a school administrator. Yes getting a masters degree at the UW has helped me advance my career.

2. How did participating in the MSBT program influence you as a teacher?

I was greatly influenced and challenged by the research component in the BioEngineering department. I still have a connection there as this year I co-direct the third summer BioEng camp for the first full week in August. It was the relationships that I developed through my MAT and through the Partners in Science Research Grant that gave me this opportunity. I highly recommend you encourage teachers who might be participants in the MSBT program to contact Murdock Charitable Trust http://www.murdock-trust.org/grants/formal-program-grants-science.asp and apply for the grant. That research dove tailed with the MAT program very well. Every few years I still attend the Murdock sponsored conference in San Diego in January. I had never done science research at that point and doing so helped me communicate with students a concrete example of science in action.

3. What were the strongest points of the program and what aspects of the program, if any, do you think could be changed or improved.

I greatly appreciated the cell biology class. At that time it used small group lab sections to study and understand current research, especially in understanding the properties and function of cell surface proteins. The zoo animal behavior course was also a hands-on, research based course in animal behavior. I studied the effect of the summer concert series on the wallaroo population. Another aspect I liked was the one credit seminar series that could fulfill part of my credit requirement.

The only disadvantage of the program when I attended was the timing of when courses were offered. Many were not available in the summer or evenings. I actually took a partial leave of absence and paid for my own sub to take a morning class three days per week one quarter.

Other: The program was flexible enough to allow me some freedom in course selection. That helped me take classes that more directly applied to my teaching at the time (10th grade biology, marine biology, and chemistry).

GLEN MACMASTER 2007

1. What are you doing now? Did the MSBT help advance your career?

1. I am teaching high school biology in San Mateo school district in California. I will be graduating with the MSBT at the end of the summer so it hasn't advanced my career (yet).

2. How did participating in the MSBT program influence you as a teacher?

2. My research project experience was incredible and extremely challenging! I learned more than I could have imagined. I learned tons of content from different areas of Biology, including; marine organisms, molecular biology, genetics, and evolution. I also benefited from actually performing scientific techniques, including; cloning, sequencing, making probes, in situ hybridization, taking photos w/ microscopes, etc. My project gave me an opportunity to write a paper for publication. I now understand the steps and time required for writing scenic papers. The challenges and experiences I encountered have made me more confident with current concepts in biology and have helped my teaching. Now, I can better explain concepts and lab techniques to my students. The MSBT program has, and will have, a great impact on me for which I am grateful.

3. What were the strongest points of the program and what aspects of the program, if any, do you think could be changed or improved?

3. *It's been a great program and I am very satisfied*.

BILL MONAHAN 2002

1. What are you doing now? Did the MSBT help advance your career?

1. I am currently teaching high school biology to sophomores, and teaching AP Biology to primarily seniors. Next year's classes will be approximately 90 sophomores and 60 seniors. The MSBT program enabled me to extend my teaching certificate for 5 years without any additional clock hours.

2. How did participating in the MSBT program influence you as a teacher?

2. I have a much better understanding of molecular research tools as a result of the MSBT research component, which enables me to relate the lab work we do on a much more understandable level with the students.

3. What were the strongest points of the program and what aspects of the program, if any, do you think could be changed or improved.

3. The strongest component was the research piece. It also the hardest and most time consuming. I always enjoyed the classroom time with professors. One thing that might improve the program would be a way to facilitate the research relationships between students and prospective researchers. As a working teacher who was out of the mainstream as far as course interactions with professors, it was difficult to find a mentor for research purposes.

LISA MONAHAN (COMISKY) 1999

1. What are you doing now? Did the MSBT help advance your career?

I am teaching H.S. Biology, Chemistry, and various Math classes in the Methow valley. After my experience in Mississippi as part of Teach for America, I returned to Washington and entered the MSBT program. This allowed me to take the courses I needed to secure a Washington State certificate and get an endorsement in biology.

2. How did participating in the MSBT program influence you as a teacher?

The MSBT helped me gain invaluable experience in doing Science. A methods class in Scientific Inquiry is worthwhile, but seeing a project through to the end provides a much more personal connection to the processes, frustration, and elation of science. I feel confident contributing to our district's reorganization of Science Education. I believe the MSBT program offered me the time to seek resources and reinforced where to focus our energies at a middle and high school level.

3. What were the strongest points of the program and what aspects of the program, if any, do you think could be changed or improved.

I appreciated the individual approach of the program, but I missed the potential collaboration opportunities of working with colleagues in a track of classes.

NATHAN OXNARD 2006

Written communication 7/20/2006: *"As I wrap up my days at the UW and pack up the apartment for our big move back east, I want to thank you for all of your assistant during the MSBT program. My experience here was even more interesting and engaging than I had anticipated, and I feel significantly more qualified to teach science than before. In retrospect, I had no idea what I was doing before! Despite all my best-laid plans to return to the secondary level, I will be teaching 8th grade again in the fall. I'm excited, though, as I feel like I've found a community in rural NH where I'll be able to make a difference."*

MICHELLE ROGERS 2004

1. What are you doing now? Did the MSBT help advance your career?

I am currently living abroad in France. I run a very small business that does educational cultural and natural ecology tours in France. This is just a few programs each year though, so I also work as an adjunct online professor at two universities in the USA as well teaching environmental science, general ecology/biology, and I also work in environmental education.

After my master's program at the UW I was able to then enter into an education specialist degree program in education leadership. I just graduated from that program this last June 2007. I am now entering a doctorate of education in instructional technology and distance learning. I couldn't have done the EdS or now the Ed.D without first having done the MSBT...as my undergraduate was in science. The MSBT spanned the fields of education and science, and allowed me to combine those disciplines and move on into higher degrees in education.

This is quite a mixture of things to have done. The MSBT made it possible. Because it spanned both the education and science department I was able to get the mixture of education I needed to now work as an online science teacher to adults as well as do natural and cultural ecology programs in France.

I already have my advisor and most of my graduate committee in place for my Ed.D. I will be helping a prominent professor in the field of environmental education convert his on-ground courses to online courses. My Ed.D thesis will be the expansion of environmental education

through online learning. Again, this wouldn't have been possible without having first done the MSBT, as in that program I had the option of taking environmental education courses at IslandWood to supplement my learning, which prepared me for the online environmental science teaching I do, as well as my future Ed.D thesis and research.

In conclusion: the MSBT helped advance my career greatly.

2. How did participating in the MSBT program influence you as a teacher?

My participation in the MSBT influenced my teaching in the fact that it spanned both the education and science disciplines. Prior to this program all my undergraduate studies were only in the hard sciences. I had no educational theory. The MSBT required me to take courses in the education department thus improving my knowledge of learning theories and curriculum development. This in turn made me a much better teacher.

3. What were the strongest points of the program and what aspects of the program, if any, do you think could be changed or improved.

I liked that the program was flexible...it was flexible in how long it took to do it...and also flexible in letting you really choose what courses, subject and topics you were going to focus on.

First example: I did have to choose one microbiology course for my degree. Yet, the program is flexible about what kind of micro course you choose. Since my focus was and is environmental science/education and natural ecology I was allowed to take a Forest Pathology course from the Forestry department to cover this requirement rather than a traditional microbiology course about human pathogens (which ultimately would have been far less useful to me).

Second example: I knew that I didn't plan on teaching high school or below. I planned on teaching to adults. Because this program was flexible I was able to take education courses on learning theories and curriculum development that I could apply to adult learning while still meeting the MSBT program requirements.

These two examples represent the flexibility that allowed me to meet the program requirements while still studying within the scope of topics I wanted and needed, and made sure what I took was useful to my future teaching career.

I can honestly think of very little the program could improve upon. It might be nice to have more of the courses online, as then teachers could keep working while doing the program. I think that a teacher's professional experience is integral to their studies as well, and thus more online options would allow this. Since the UW has so little online I, for example, had to quit my job to do the courses. This sometimes made funds tight, and ultimately I was gaining little work experience while doing the program. That would be my only suggestion for improvement.

Overall, this program was great. I'm really glad I had the opportunity to complete it.

MARTHA STACHANS 2003

1. What are you doing now? Did the MSBT help advance your career?

1. I am currently teaching Biology, AP Biology and Anatomy/Physiology as well as serving as

the science department chairperson at Meadowdale High School in the Edmonds School District. The MSBT furthered my career by providing me with an even stronger science background. I was already certified in General Science but the added science courses were much more valuable to me than any of my education coursework.

2. How did participating in the MSBT program influence you as a teacher?

2. I suppose the most influencial aspect of the MSBT program was meeting other teachers in the program and learning about the variety of interests they had in science.

3. What were the strongest points of the program and what aspects of the program, if any, do you think could be changed or improved.

3. Without a doubt the strongest aspect of the program were the number of science courses required. All of my science courses were so much more valuable to me than any education courses that I took. The science teaching methods courses were useful but the knowledge that I gained in the courses in my content area is what I really use.

JUDY STANHOPE 1990

1. What are you doing now?

I just completed my 28th year of teaching science at Scarborough High School in Scarborough, Maine. My teaching assignment is currently college prep biology and honors biology. In past years, I have taught college prep chemistry and AP Biology, and I may be teaching AP Environmental Science this coming school year.

2. How did the MSBT program influence you as a teacher!

Tremendously! When I was searching for the appropriate graduate program, I had three goals in mind; all of which the MSBT program fulfilled. Before elaborating, however, I would like to recognize the fact that the excellent administration of the program; and the advice and guidance provided by Helen Buttemer and Dr. Joseph Ammirati, my research project advisor, played an important role in helping me fulfill these goals.

First, teaching biology requires a good solid foundation of the several biological disciplines. My undergraduate biology degree provided an excellent base, but I wanted more. The MSBT program enabled me to take a variety of biology courses that expanded and updated my knowledge of the several fields of biology I expose my students to.

Second, I wanted to experience real scientific research, something my undergraduate program did not provide, and something as a science teacher, I felt was important to have first hand experience in. In the MSBT program, I actively engaged in scientific inquiry. This was one of, if not the most rewarding part of my experience. My only regret is I wish I could have remained at UW for a longer period of time to continue to expand my knowledge and to delve deeper into my research .

Finally, as an educator, I wanted to interact with other educators. The weekly teaching seminar was very beneficial. It provided an opportunity for educators to share ideas and teaching methods, and to discuss concerns and recent research. I am glad; however, that the program's

major focus was on the biology. I love the science and the more I learn the better the teacher I become.

3. What were the strongest points of the program and what aspects of the program, if any, do you think could be changed or improved?

The program, offers an excellent opportunity for biology teachers to pursue their graduate education. There are two things educators need, both professionally and personally; the time and the resources to continually update their knowledge and skills in their profession, especially in their field of study. The MSBT program provides this in the following ways:

- *The program's flexibility enables teachers working full time to pursue their MSBT degree.*
- *The research component and course requirements enable one to expand their knowledge and skills.*

JAMIE WAKEFIELD (TANAS) 2003

1. What are you doing now? Did the MSBT help advance your career?

1. I am currently finishing my fourth year of teaching at Mountlake Terrace High School in the Edmonds School District. I have had the opportunity to start an advanced placement biology program at the high school and will finish the second year of the course this June. I think the MSBT program gave me the creditbility, knowledge and experience to begin that type of program sucessfully so early in my career.

2. How did participating in the MSBT program influence you as a teacher?

2. I think participating in MSBT greatly increased my breadth of knowledge as a teacher and allows me to more easily make relevant connections throughout the MANY topics that we cover in a introductory biology course.

3. What were the strongest points of the program and what aspects of the program, if any, do you think could be changed or improved.

3. I think the strongest aspect of the program is its flexibility. I greatly benefited from being able to choose the courses that I felt would be the most useful for me as a teacher, according to my background and previous experiences. I was able to fill in many of the gaps in my knowledge base, and expand on those I was most interested in.

STEPHEN LARNER 1997

After leaving UW I went on to pursue a PhD at the encouragement of several of the professors I had the opportunity to work with there. After getting my PhD in Neuroscience here at the 2006 football and basketball National Champions University of Florida Gators I spent the next 3 years working as a post doctoral associate in the same lab I got my PhD in. I liked the work and the professors I was working with so I stuck around. Recently they decided to move all their operations to a company they had started up in 2002 and asked if I was interested in joining them. Of course I said yes because I would now be able to combine my science experience and business background. I now have the title "Principal Scientist" but I also have the unofficial title "Operations Officer" for the division, the Center of Innovative Research, for Banyan Biomarkers (the basic and applied research arm for company) as well as possible future CFO for the

company.

MSBT allowed me to get the experience in the lab, improve my understanding of the sciences, and how to get across information to other people, similar to what a teacher would do. As a post doc I became involved in the lab in ways that was not typical of most post docs that I am familiar with. While most post docs concentrate on their research I was heavily involved in training technicians (they have since gone on to a PhD program, MD program and a DVM program - Vet doc), undergrads (one is now in a PhD program, the other is in a MD program), and I am currently working with graduate PhD candidate students (one has graduated and two others will graduate within a year). Obviously teaching in the classroom differs from teaching within the laboratory however the same challenges apply including motivation, education and application. For example, one of techs I hired, who did not have a very illustrious undergraduate educational background in biology, not only began to see the benefits of what we were doing, even if a bit dull, but found a niche for herself and now wants to pursue it with more education as a PhD student.

One of the strongest points of the MSBT program was the opportunity to get a world class education learning the requirements necessary to understand what really goes into scientific discovery. It also forces one to appreciate how scientists actually arrive at their scientific conclusions. This can also be a potential drawback. If someone is like me and becomes enamored with the discovery process and the science they may move in that direction and away from the classroom. I am not sure that is a bad thing if it pushes discovery process forward to the benefit of humankind.

Improvements or changes - I am not sure I can come up with any. It all worked for the best for me so I have no complaints.

CINDY UPDEGRAVE (2007)

1. What are you doing now? Did the MSBT help advance your career?

I graduated in June 2007, and since then I have continued to teach at the University of Washington in several different departments: Community, Environment and Planning Program (CEP) in Urban Planning: CEP 498 and URBDP 599: Bioregional Field Studies Summer, a course taught in the Summer Sustainability Series. I was able to develop this course initially 5 years ago using an RA-ship through the MSBT Program. The class was originally called Biology 226, Land Use and Water Quality Issues of Puget Sound. In addition, I teach Pacific Northwest Regional Ecology, field studies in Neah Bay, WA, and at the Wind River Experimental Forest and Mount St Helens.

I am now an ongoing naturalist in residence at the North Cascade Institute, writing curriculum for the Enduring Legacies project through Evergreen State College's reservation-based Bachelors program & I am a consultant for the Biology Working Group of the Bioregional Curriculum Project through the Washington Center for Excellence in Undergrad Education.

2. How did participating in the MSBT program influenced you as a teacher?

I had the flexibility and intellectual freedom to immerse myself in the topics and teaching that I was most compelled to do. It was wonderful to be a part of a small independent interdisciplinary program and receive outstanding advising and mentorship by Helen Buttemer. Outstanding

mentoring and professional development! That was the best part. Plus, I love borrowing the MSBT classroom-it is a great teaching resource!

3. What were the strongest points of the program and what aspects of the program, if any, do you think could be changed or improved?

The freedom to pursue what most compels and motivates was the most valuable. I could not have accomplished what I did without the intellectual trust and flexibility and the one quarter of research support enabled me to create the core building blocks of field learning that I rely on for K-5, 6-8, high school and higher ed teaching. In an ideal world, there would be more RAship money, I felt like I was in my own personal think tank for a quarter, it was critical to my development.

Appendix L. Supporting Letter from Biology Department

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August 28, 2007

Doug Sprugel,
Director and Chair, MS Biology for Teachers program
Professor, Forest Resources, Box 352100

In advance of the Graduate School review of the interdisciplinary M.S. in Biology for Teachers program, I would like to reinforce the Biology Department's support. The program is particularly important and valuable to secondary school teachers in the biological sciences and we are committed to it's continued success. We are pleased to provide a physical home for the program in Hitchcock Hall and to support Helen Buttemer, Biology Department lecturer and director of our Biology for Teachers program, as the graduate advisor for the MSBT program. Members of the Biology Department have provided leadership for this program for more than 30 years: past advisory committee chairs include Professors Ingrith Deyrup-Olsen, John Edwards and Johnny Palka. In addition, many of our faculty actively participate in the program's steering committee.

In an effort to increase the visibility of the program in our department, we have done a number of things: posted photographs of MSBT students in our departmental "Wall of Fame", included MSBT students in our graduate functions (although few of them choose to participate, perhaps because they are not on campus very often), and secured funds from the Charlotte M. Crary Foundation to support a biology teacher who wishes to convert his or her research project into a classroom activity. Although we have no dedicated graduate funds to support MSBT students, we often hired them as TAs whenever positions are available.

The Biology Department is committed to strengthening and improving K12 science education in Washington by playing an active role in science teacher preparation at the University of Washington. I would like to emphasize how important this program is as a link between University academics and K-12 education. The MS in Biology for Teachers is a superior graduate program for the professional development of secondary biology teachers and we are proud to be associated with a program of this caliber.

Sincerely