

Experimental Study Group

Overview

The Experimental Study Group (ESG), now in its 40th year, continues to offer innovative opportunities in teaching and learning to a variety of MIT undergraduates, faculty, staff, and alumni. In keeping with our original mission, ESG provides first-year students at MIT with personalized instruction in the core subjects within a close-knit community environment. This instruction includes flexibility in pace and scheduling and small classes where students are encouraged to ask questions and get to know fellow students and instructors. Over the years, students have consistently said that ESG's small-group learning and community atmosphere were some of the most rewarding aspects of their MIT educations.

Each year, ESG offers approximately 40 undergraduates the opportunity to assist in some aspect of teaching at ESG. All student instructors receive midterm and end-of-term evaluations from freshmen and meet regularly with staff members for supervision. New student instructors participate in a weekly teaching seminar run by senior ESG staff. Experienced student instructors who have demonstrated excellent teaching skills are able to develop their own pass/fail seminars or teach core subjects under faculty supervision.

Over the past 20 years, ESG has served as a center for educational innovation in the undergraduate program by offering a series of hands-on, interactive seminars in a variety of subjects that are not otherwise offered at MIT. These seminars provide all MIT undergraduates with the opportunity to participate in the ESG style of learning (small, interactive classes). Non-ESG students who take these seminars frequently say the seminars are the only opportunity they have had since their freshman year to participate in a small interpersonal class with a hands-on focus. This year, we ran 12 seminars through a combination of funds from the dean of the School of Science and our own alumni. We are strongly committed to continuing these seminars and promoting their growth by working closely with various parts of MIT, outside sources, and our own alumni to secure more permanent funding for them.

Student Statistics

Fifty-nine freshmen were enrolled for one or more terms in ESG this year, with another 50 students waitlisted in the fall term, the highest number in ESG's history. Forty-nine percent of our students were female, 30 percent were underrepresented minorities, and 17 percent were international students. In addition to these students, we enrolled 23 students in our teaching seminars (SP.231 and SP.232) and 79 students in our undergraduate seminar program (50 of whom had never been in ESG as freshmen). Forty undergraduates served as teaching assistants, graders, and student instructors. These upperclassmen collectively maintained an impressive 4.6 grade-point average.

Staff and Faculty

ESG's administration was headed by mechanical engineering professor Alexander Slocum and included associate directors Dr. Peter Dourmashkin and Dr. Holly Sweet

and program coordinator Graham Ramsay. The physics staff was headed by Dr. Dourmashkin and included Dr. Analia Barrantes and Dr. Sahana Murthy, a specialist in physics education research. The mathematics staff was headed by Dr. Jeremy Orloff and included Dr. Gabrielle Stoy. The chemistry and biology offerings at ESG were taught by Dr. Patricia Christie. ESG's School of Humanities, Arts, and Social Sciences (HASS) staff included Mr. David Custer, Dr. Lee Perlman, Dr. William Haas, and visiting professor Svetozar Minkov from Roosevelt University.

Faculty Advisory Committee

Members of the ESG faculty advisory committee included professors Robert Silbey (chair), John Belcher (Physics), John Gutttag (Computer Science), Hazel Sive (School of Science), Charles Stewart (Political Science), David Vogan (Mathematics), and Graham Walker (Biology). Ex officio members of the committee included professor Kim Vandiver (former ESG director) and Professor Slocum (current ESG director). The committee met twice during the year to provide oversight for the ESG program, including staffing and funding issues, educational policy, and exploration of academic initiatives for the program. This committee was active in spring 2009 in terms of assessing how to create greater connection with the Office of the Dean for Undergraduate Education and in helping bring more faculty into ESG.

Alumni Steering Committee

The ESG alumni steering committee was headed by Richard Hilliard '76 and included Ian Eslick '95, Peter Fiekowsky '77, David Glazer '81, David Henkel-Wallace '86, Jeremy Hurwitz '08, George Hu '89, Andrea McGimsey '87, Gregory Moore '73, James Rising '03, Jocelyn Rodal '06, Matthew Wilbert '80, and Raja Bobbili '08 (also a recent member of the MIT Corporation). The committee met several times during the year to give input to ESG staff about a variety of issues, including finding ways to fund the ESG seminar series, organizing reunions, and reviewing current educational policy and initiatives.

ESG Undergraduate Seminar Series

Because of its small size and experimental educational focus, ESG provides an ideal environment in which staff, faculty, alumni, and students can develop new subjects and new approaches to existing subjects. This year we continued the ESG seminar series with 12 seminars, two of which were developed and run by undergraduate students under staff supervision. Seminars offered for the first time this year included SP.264 Greek Philosophy and Mathematics, SP.265 Psychology of Terror and Hope, SP.266 Chaos Seminar, SP.268 Mathematics of Toys and Games, and SP.269 Flexibility in Race and Gender.

Energy Initiatives

Professor Slocum has been very active in the MIT Energy Initiative this year and is leading the ESG staff in a drive to bring the theme of "Energy Study Group" to ESG. Based on a proposal that Professor Slocum and the ESG staff wrote, the Energy Task Force has committed two full-time graduate teaching assistants to work with ESG staff in the 2008–2009 academic year to develop energy-related context problems and examples to be tested in the General Institute Requirements (GIRs) taught in ESG. Once refined, the materials can be used in GIRs in the regular curriculum to help better prepare and

motivate freshmen for possible selection of the new minor in energy studies that MIT is planning to offer starting in fall 2009. Integration of the new material developed and tested at ESG into the regular curriculum GIRs is made possible primarily because ESG instructors are members of the School of Science and work closely with the School of Science professors in charge of the GIRs.

Michael Blair, a chemistry graduate student, worked on developing the problems for both chemistry and biology. In collaboration with Dr. Christie, Mr. Blair produced four energy-related problems per week tied into the chemistry curriculum for 5.111. For the ESG 5.111 students, there was a mandatory energy workshop session once a week run by Dr. Christie in which two of the energy problems were discussed. The 5.111 students also went over an additional problem in recitation and then saw the fourth problem on their homework. Mr. Blair ran an optional weekly energy workshop for the 5.112 students. Some of the chemistry energy questions covered included combustion, photon energy, hydrogen as an energy source, solar cells, energy conversion, thin films, catalytic converters, and the kinetics of ozone depletion. ESG now has a term's worth of energy-related problems that will be used in the first half of the fall 2009 5.111 and 5.112 mainstream classes. During spring 2009, a similar approach of generating workshop problems to accompany the course material was taken for ESG biology. Two energy-related problems a week were created; one was discussed in problem solving (led by Dr. Christie) and one was given to the students on a problem set. Students read articles with a biology/energy focus and used the workshop time to discuss the article and answer questions. For a sample set of chemistry and biology problems, see <http://esg.mit.edu/energy-initiatives/>.

The math staff worked closely with graduate student Chris Evans, who developed 50 suites of energy-related problem sets ranging from the purely theoretical (i.e., thermodynamics) to the applied (i.e., windmills) for the core math curriculum. The goal of assembling these problems was to use them as a teaching resource to introduce students to important concepts in energy, which use the fundamentals of mathematics and physics learned in the GIRs. The math staff and Mr. Evans held three workshop meetings with upperclass teaching assistants in ESG to work through some of the problems and obtain feedback on the appropriateness for problem sets, classroom material, or projects. Dr. Stoy used a number of them in 18.02 in ESG in both fall 2008 and spring 2009. Dr. Orloff also used some problems in his 18.03 courses in Concourse and ESG in spring 2009. In addition, John Kim '10 did an Undergraduate Research Opportunities Program (UROP) project in ESG under the supervision of Dr. Stoy, where he identified and developed some of the energy-related problems into student projects. Project material was developed based on different energy-related areas addressed in the database of problems and using the problems themselves. The 18.02 ESG class used them in spring 2009 and gave in-class presentations. The adaptation into projects was put on the class website by Mr. Kim, who also helped with supervision of the projects. See <http://web.mit.edu/lcevens/www/Energy/> for more information about these problem sets.

Pedagogical and Curricular Innovation

In fall 2008, Mr. Custer taught 21W.732 Introduction to Technical Communication. This class was coupled with a mechanical engineering design seminar in which students worked in small teams to create products of their own design and learned to write with passion and ownership. Professor Slocum taught a new freshman advising seminar, SP.233 Precision Instruments, in fall 2008. In spring 2009, Professor Minkov taught a new HASS class, SP.2H2 Philosophy of Technology, while on sabbatical from Roosevelt University.

ESG offered an innovative academic program in spring 2009 that consisted of three subjects—a HASS class, 21W.781/ESD.032 Colossal Failures in Engineering (Dr. William Haas, Mr. Custer, and professor Thomas Eager), and two undergraduate seminars, SP.266 Chaos (Dr. Christie) and SP.265 Psychology of Terror and Hope (Dr. Sweet). The program was funded jointly by the Office of Naval Research, ESG, and the Schools of Engineering and Humanities, Arts, and Social Sciences, the first time this pairing has occurred. The aim of the program was to acquaint students with the scientific, political, and psychological implications of potentially catastrophic situations and to help students create effective problem-solving techniques, while cultivating a positive and proactive attitude that can help them better confront and solve problems that arise from such situations. The HASS class will run again this fall, with an end result being a draft of a screenplay based on a band of MIT students outthinking terrorists.

Staff Publications

In November 2008, ESG's first book, entitled *A Creative Guide to Exploring Your Life: Self-Reflection Using Photography, Art, and Writing* (Jessica Kingsley Publishers, coauthored by ESG staff members Mr. Ramsay and Dr. Sweet), was published. This book is based on an ESG seminar (SP.240 Composing Your Life), which has been taught at MIT by the authors for the past four years. With funding from the D'Arbello Foundation, Dr. Perlman is completing a book about Greek philosophy and mathematics based on a class he has developed and taught at ESG for the past three years.

Dr. Barrantes, along with physics professor David Pritchard, worked on a Wiki textbook (*Hierarchical Modeling Approach Using Electronic Organization*) for introductory mechanics, which uses ideas from modeling physics to encourage strategic, concept-based problem solving. This e-book is aimed at enabling a shift in the role of the textbook from an authoritative serial repository to a modular, searchable, and customizable hub that will provide a clear overview of the domain, short summaries of key content, and links to more detailed resources. The Wiki textbook will incorporate these features naturally, will allow for student feedback, and can serve as a customizable supplement to any existing course using any mechanics text. Dr. Dourmashkin continued his collaboration with professor Eric Mazur of Harvard University on a new first-year physics textbook.

Staff Conferences

With professor Bernhardt Trout, Dr. Perlman helped organize a conference in May 2009 on integrating sciences and humanities at MIT, which included a number of MIT students (many of them from ESG), faculty members, deans, and some faculty members

from other institutions as well as some representatives of foundations with interests in education. The conference was funded by the Jack Miller Center. In June 2009, Dr. Perlman and Professor Trout hosted a five-day seminar at MIT on the philosophy of science. Students from around the country participated, along with a number of MIT students. Dr. Perlman and Professor Trout were both instructors in the seminar, as were some faculty members from other institutions. The seminar was organized by the Institute for the Study of Nature, of which Dr. Perlman and Professor Trout are fellows.

Dr. Dourmashkin was invited to speak at several national and international meetings and universities this year on the subject of physics education, including the following:

- “Using Visualization in Teaching Introductory E&M” at the American Association of Physics Teachers National Summer Meeting, Canada, July 2008
- “Redesign of Mechanics and Electromagnetism at MIT” at Pearson Education’s (a higher education publishing company) Course Redesign Workshop, Tucson, AZ, October 2008
- “TEAL at MIT: Physics Education Innovation at a Research University” at the National Chung Cheng University, Taiwan, May 2009
- “Physics Education at MIT” at the Niels Bohr Institute, Denmark, June 2009
- “A Case Study of Active Learning” at the Aarhus University, Denmark, June 2009

ESG Awards

ESG gave its own set of awards in May 2009, including the Peter and Sharon Fiekowsky Community Service Award (for outstanding contributions to the ESG community) and the Fiekowsky Excellence in Teaching Award (given to graduating seniors who have demonstrated excellence in teaching at ESG over a sustained period of time). Mr. Fiekowsky is a former ESG student and a graduate of MIT and he has established funding for annual ESG prizes in these categories. Winners of the 2009 teaching award included graduating seniors Paul Boudreau, Mariya Gusman, and Carmel Mercado. Winners of the 2009 community service award included Melissa Gymrek ’11, Paul Kominers ’12, and Alexandra Piotrowski ’11.

Fortieth-Year Anniversary Party

ESG kicked off a year-long series of celebrations with a 40th-year anniversary party on the weekend of April 3–5, 2009. Seventy ESG alumni and current staff and students attended and a brainstorming session was held on April 5 to get a sense of the main value of ESG to both ESG alumni and MIT as a whole from an alumni perspective. A sample of answers about what being in ESG meant to alumni included the following:

- flexible approach to learning
- interesting in-depth seminars
- educational freedom to pursue learning
- a vibrant academic/social community

- a physical space for free-flowing sharing of ideas, interests, and expertise
- learning by teaching
- smaller classes that are better paced for student learning
- opportunity to take initiative educationally and be able to do it with a minimum of red tape

Alumni were also asked what they considered to be ESG's value to MIT. Sample answers include the following:

- place for students to discover themselves and their interests
- development and training of future teachers
- diversity of educational methods and learning styles
- friendlier and "less scary" version of MIT
- opportunity for students to learn how to develop and teach their own seminars
- more multidisciplinary than mainstream
- incubator/testbed for new courses
- collaborative learning community
- place to experience student-centered learning
- more personal interaction between students and faculty/staff
- special connection of ESG alumni to MIT because of their sense of belonging to the ESG community

Fundraising

Under the guidance of Elizabeth Chadis, fundraising officer for the School of Science, ESG initiated the first phase of a fundraising campaign to raise \$500,000 over a five-year period to endow the ESG seminar series. This phase consists of raising \$250,000 from several lead donors with gifts of \$10,000 or more (Ian Eslick '95 and Gregory Moore '73) and secondary donors of \$2,500 or more (Herb Lin '73, Peter Fiekowsky '77, David Henkel-Wallace '86, and Alex Slocum '82). As of June 30, 2009, \$125,000 has been raised. We will be continuing our efforts in the next year.

Collaboration with Other Parts of MIT

In the spirit of more effective and efficient undergraduate education at MIT, ESG has sought to increase its connections with other parts of MIT this year.

Dean for Undergraduate Education: In spring 2009, Dr. Sweet served on a task force (led by Dr. Lori Breslow and Professor Vandiver) to study ways to make the freshman year more integrated and more cost-effective. Recommendations for ESG included recruiting more faculty into ESG, expanding ESG's faculty advisory committee to include Concourse, and working more closely with Concourse and the Office of Minority Education to share staff and offer joint courses, workshops, and tutor training programs wherever possible.

Office of Minority Education/Interphase: In June 2009, the Interphase program, sponsored by the Office of Minority Education, purchased copies of *A Creative Guide to Exploring Your Life* (Ramsay and Sweet) for its teaching assistants. Mr. Ramsay and Dr. Sweet ran several exercises from their book with this group. Plans have been made to incorporate more of the book's exercises in the 2010 Interphase program. Dr. Christie heads the chemistry offerings in Interphase in addition to teaching chemistry in that program. Several ESG upperclassmen also tutor in Interphase.

Concourse: ESG shared several staff members with Concourse, including Dr. Murthy (Physics), and Dr. John Lewis, Dr. Orloff, and Dr. Stoy (Mathematics).

Physics Department: Dr. Dourmashkin was very active in collaborating with visitors about the Technology Enabled Active Learning program, including meeting with the director of the London Transport Museum and other visitors from universities and high schools. Dr. Dourmashkin, along with Peter Wilkins from the MIT Office of Educational Innovation and Technology, also cosponsored two UROP students. The students worked on SpokenMedia, a project in which they designed a student interface for searching the Walter Lewin physics lectures.

Writing Program: Both Mr. Custer and Dr. Haas taught in the writing program and collaborated on a joint project, Colossal Failures in Engineering, in spring 2009.

Conclusion

We are dedicated to offering undergraduates opportunities to teach and learn in a collaborative, interactive environment. We are proud of our history of educational experimentation, including our seminar series and publication of books based on materials developed at ESG. In the coming year, we will continue to work on increasing faculty and alumni involvement with ESG and to look for ways to export successful ESG educational experiments to the regular curriculum and to educational settings outside MIT.

Peter Dourmashkin
Associate Director
Senior Lecturer in Physics

Alexander Slocum
Director
Professor of Mechanical Engineering

Holly Sweet
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More information about the Experimental Study Group can be found at <http://web.mit.edu/esg/>.