The Mayo Innovation Scholars Program: Undergraduates Explore the Science and Economics of Medical Innovations

By John J. Pellegrini and Elizabeth Jansen

The Mayo Innovation Scholars Program introduces undergraduates to technology transfer in biomedical sciences by having teams of students from multiple disciplines (e.g., biology, chemistry, economics, and business) analyze inventions in development at the Mayo Clinic. Over 6 months, teams consult with inventors, intellectual property experts, and faculty mentors as they research and explore project viability, potential applications, market forces, ethical dilemmas, and financial considerations. Team members read relevant patent applications as well as journal articles from within the basic sciences, clinical sciences, and business. In some instances, they perform original research, such as surveys of health care providers or potential consumers. The program culminates in formal presentations that include teams’ recommendations about what should be done with the invention (e.g., shelve it or pursue a licensing agreement, or pursue some other option) to an audience of intellectual property experts, physicians, faculty, and student peers.

Science educators find it challenging to make their curriculum all they want it to be and all that research indicates it should be: rigorous, engaging, relevant, and interdisciplinary. But at 11 Minnesota private colleges, the Mayo Innovation Scholars Program (MISP) provides an opportunity for students to experience learning with all of these attributes. By participating in a program that explores the intersection of biomedical research and business, students and faculty wrestle with the possibilities and difficulties of turning current discoveries into advances in science and medicine.

Organization and founding principles

The program began in 2005 after John Meslow, a retired executive from the medical device industry, gained insights into the workings of Mayo Clinic’s intellectual property development office. The intellectual property development office engages in technology transfer, helping to bring new technologies developed by Mayo clinicians and scientists to the medical marketplace. When Mayo Clinic physicians and scientists make discoveries with possible clinical applications, they bring their ideas to the technology and licensing managers of the intellectual property development office. These experts investigate the potential of the new inventions and pursue various strategies for development, such as filing patent applications, entering into licensing agreements with external companies, or recommending formation of a start-up company. Because there are thousands of researchers at Mayo, the 15 managers in the intellectual property development office manage hundreds of ideas for new inventions each year. Meslow saw the opportunity to create a mutually beneficial collaboration between the intellectual property development office and teams of undergraduate students from Minnesota private colleges. Students would provide the intellectual property development office with fresh perspectives and useful research on the scientific and business possibilities of an invention, and the intellectual property development office would provide students with real-life, interdisciplinary research opportunities at the leading edges of medical technology. Meslow brought together educators from area colleges, technology-transfer professionals from the Mayo Clinic, administrative support from the Minnesota Private College Council (http://www.mnprivatecolleges.org/misp), and a source of funding for the program through the Medtronic Foundation. The Medtronic Foundation supports the program as part of its mission of “educating future generations of scientific innovators” (http://www.medtronic.com/foundation). One year into the program, Meslow, director of the program, recruited Liz Jansen, biology faculty
member from Macalester College and faculty mentor to the Macalester College teams, to serve as academic program director, thereby crafting an administrative structure that mirrors the core mission of the program: bringing together biomedical scientists with business practitioners.

The three main objectives of the program are as follows:

- to assist the Mayo Clinic intellectual property development office in the assessment of new product submissions from Mayo researchers,
- to provide research opportunities for undergraduate science and business students, and
- to provide leadership development and research opportunities for graduate students.

The order of the objectives is intentionally listed this way (mnprivatecolleges.org/MISP) because the program specifically emphasizes the need for the teams’ final reports to be of value and use to the intellectual property development office; program directors recognized that the program will not be sustainable if it is “just an academic exercise” for the students. Effective partnerships between colleges and community groups require some reciprocity and mutual benefits, as has been emphasized in the area of service learning (Greene, 1998). This real-world setting and application characterizes the program and motivates the teams to create thorough, professional, and useful final reports.

Program participants and their roles

MISP involves cooperation between the program’s administrators, college faculty mentors, intellectual property development office staff, and students in science and business or economics. Although that might seem like a lot to manage, the program staff consists of only three part-time members: the program director, the academic program director, and an administrative assistant. The student teams typically consist of four undergraduates (two majoring in scientific disciplines and two majoring in economics or business) plus one graduate student team leader from a masters-level program in business or leadership. Faculty participation varies across campuses, with between one and five faculty members serving as mentors to the teams at each institution. Each team is assigned one technology/licensing manager from the intellectual property development office to serve as a resource during the research phase and to help develop and clarify the deliverables and salient questions. In addition, that manager will arrange visits with the inventors and review the team’s final work products (oral presentation and paper; see Figure 1).

MISP directors set the goals of the program, evaluate it, coordinate its major events, and work out logistics. In consultation with the Mayo Clinic intellectual property development office, the directors select inventions that lend themselves to undergraduate student research, that is, those that are novel, relatively clear in their definition, and accessible (not too amorphous or meandering in their application). They then survey participating schools to match school interests with available inventions. After assigning the projects, program directors organize an orientation session for faculty mentors and graduate student team leaders to explain the objectives, expectations, and schedule of the program and to introduce graduate student team leaders to the undergraduate faculty mentors. Specifically, they emphasize the necessity to keep all proprietary information confidential because this is the first experience for many program participants with such conditions. In addition, they describe the nature of the final work products and review the timeline (the bulk of the research is done in January and

![Figure 1](image-url)

A schematic representation of the organization of the Mayo Innovation Scholars Program.
the required presentation occurs at the Mayo Clinic in March). They also distribute a student handbook, so that all participants have a detailed reference concerning goals, logistics, and frequently asked questions (see the appendix for the handbook table of contents). Following this orientation, undergraduate and graduate students attend a daylong orientation at Mayo Clinic that includes an introduction to the workings and organization of Mayo, as well as program structure and expectations, and a chance for teams to meet with their project inventors.

Faculty mentors at each college or university are responsible for assembling the teams of students and ensuring that teams make timely progress. Although the student-selection process varies across campuses, schools typically invite applications from students majoring in biology, chemistry, business, or economics. The application consists of a statement of interest that demonstrates an understanding of the program and requirements and the student’s qualifications, a copy of the student’s academic transcript, and one to two references from faculty members. Team members are usually juniors and seniors who are chosen on the basis of the strength of their application as well as their specific qualifications for that year’s assigned project. For example, if the invention pertains to a new antibody, a student who has taken immunology may be selected; if the invention uses computer technologies, a student with experience in that area may be selected. Students who are excellent and self-motivated, able to work well on a team, and willing to wrestle with the ambiguity of open-ended questions are best suited to the program.

After the undergraduates have been selected and instructed in the nature of the confidentiality requirements, faculty entrust day-to-day leadership of the teams to the graduate student team leaders. Graduate students are selected from masters programs in business and leadership. They, too, have faculty mentors from their universities whom they may call on for guidance, but the graduate student team leader is the one responsible for assigning specific tasks and deadlines to the team of undergraduates and providing them with frequent feedback on their work.

The nature of the research and specific tasks for each team varies with the nature of the invention and its developmental status. Library research, survey administration, and perhaps even laboratory tinkering might be involved. On the science side, students may review general principles but soon enter into the topic more deeply. They read textbook chapters, primary literature, review articles, and any relevant patent applications. They might head to their college’s anatomy lab to gain a better sense of the physical structures involved, or they may interview patients or clinical professionals to gain important insights. One team used school lab equipment to provide mild shocks to one other as they tried to simulate the stimulator parameters for a proposed invention. On the business side, students search for related products that are already in existence or in development (prior art). They analyze the potential markets and determine companies that might be potential competitors or partners. They assemble what business scholars refer to as a SWOT analysis, an overview that enumerates and explains the strengths, weaknesses, opportunities, and threats for the proposed invention.

In addition, thorough consideration of the ethical dimensions of the projects is emphasized. Ethical dilemmas frequently become apparent through the teams’ analyses, such as with a novel diagnostic methodology for a disease with no cure or a costly technology for a very rare condition. Finally, each team is invited to visit the Mayo Clinic toward the end of the fall semester to meet with the licensing/technology manager and, whenever possible, the inventors. In preparation for and during this visit, teams refine and begin to answer their research questions. This meeting with the inventors often serves to “bring the invention to life” for the students as they learn about the medical context or scientific need that spawned the innovation.

The program culminates in a series of presentation sessions that occur in a formal setting at the Mayo Clinic. At these sessions, the students explain their findings to the intellectual property development office, the MISP program directors, and other participating students and faculty; in some cases the inventors are also in attendance. As a condition of participation, teams agree to travel to the Mayo Clinic and attend the entire half-day sessions in which they are both presenters and audience. They are rewarded with excellent, thought-provoking talks, a fine lunch, a tour of the impressive facilities, and a stipend check ($1,000) for participation. The formality of the meeting and the grandeur of the setting encourage students to prepare carefully and communicate lucidly in what is clearly a significant event in their education. For each team, the 30-minute presentation concludes with their recommendation to the intellectual property development office. That recommendation might be, for instance, to license the technology to a specific company or it might be to discontinue pursuing any further development of the proposed invention. After the talk, the licensing manager offers specific feedback on the group’s work and its recommendation, and the floor is opened to ques-
Faculty mentors at each college give
interdisciplinary learning
environment and academic credit

Interdisciplinary learning
Regardles of the complexity of a
program is the wide diversity of proj-
specific invention, MISP aims to fos-
ter interdisciplinary work between
students and faculty in the sciences
and those in business and econom-
ics. Such an environment reflects the
interrelated world students enter after
touring the Mayo campus.

An interesting aspect of the pro-
gram involves multiple complex
patents and peer-reviewed publications,
whereas others are ideas in very early
phases or in concept only. Some
involve high-tech products or
devices and others are elegant in their
simplicity. On presentation days, the
wide range of project types paints
a microcosm of today’s biomedical
technology transfer landscape. This
real-world range of innovations—both
in terms of type of technology as well
as stage of development—means that
no single protocol or simple rubric
can characterize how teams should
research and analyze their projects.
Each team must struggle with initial
ambiguity and uncertainty in order
to define the best approach for their
project. This element provides chal-
cenges and sometimes frustrations, but
ends up yielding impressive analytical
rigor as well as the most transformative
experiences. As John Dewey (1930)
indicated, uncertainty is part of the
search for knowledge, and meaningful
inquiry leads to practical action.

Interdisciplinary learning

environment and academic credit

Regardless of the complexity of a
specific invention, MISP aims to fos-
ter interdisciplinary work between
students and faculty in the sciences
and those in business and econom-
ics. Such an environment reflects the
interrelated world students enter after
graduation (see Carter, 2008, and Hue,
Sales, Comeau, Lynn, & Eisen, 2010,
for discussions of the importance of
interdisciplinary science education).
Faculty mentors at each college give
periodic feedback to their students’
research, including feedback about
how to make the research findings ac-
cessible to nonexperts (e.g., to the sci-
ence student who has not previously
done market analysis or the business
student who has not studied molecu-
lar biology). Faculty mentors also en-
courage students to learn across disci-
plines. For example, during a progress
report meeting, mentors might ask for
science students to present the market
research and for business students to
explain the scientific components.
Although the students typically return
to their more familiar roles for the final
presentation, mentors strive to engage
each team member in all facets (sci-
cientific, business related, ethical) of the
analyses. In this way, the program is a
perfect fit for the liberal arts student.

This multidisciplinary nature of
the program provides students the op-
portunity to dive into an innovation in
development using the tools of their
disciplinary major and also exposes
students to disciplines very different
from what they have studied in college.
Indeed, some of the most gratifying
outcomes of the program have oc-
curred when students sought new areas
of study in subsequent coursework or
considered professions that they had
previously been unaware of. Business
students gaining confidence in their
abilities to master the scientific con-
ccepts enough to inform their market
analyses is a novel means by which
scientific literacy can be advanced (see
Hazen & Trefil, 2009, for discussion of
the importance of scientific literacy).
In addition, there has been more than
one science student who, after their
experience in MISP, elected to take a
business or economics course on the
basis of insights gained in the program.
These examples go a long way toward
tue liberal arts training to create an
informed citizenry.

Although certain attributes of
MISP seem unique, other attributes
are shared by initiatives within cer-
tain business schools, engineering
programs, and high schools (Moore
& Sumrall, 2008). Clearly, MISP is
fortunate to have the support of a
world-class medical research facility
and a corporate foundation that invests
in training students to be tomorrow’s
innovators in science. And while not
every college will have a nearby tech-
nology-transfer office that is willing
collaborate, it is possible that large
research universities or biotech corpo-
rations might be open to the possibility
of participating in such a program.
This program provides an example
of how approaching novel partners in
the community with new ideas about
collaborative programming can bring
about mutually beneficial partner-
ships to provide novel opportunities
for students.

Across the various participating
colleges and universities, the nature
of the academic credit that is awarded
for participation in MISP varies. Some
students are graded by their faculty
mentors and will have their participation
in the program reflected on their
academic transcripts as an internship,
independent study, or research course.
Other students will have no record of
participation on their transcripts, but
they will have gained valuable recom-
endations from faculty mentors and
are encouraged to highlight the experi-
ence on their resumes. Program direc-
tors have respected individual schools’
autonomy in deciding best practices on
the basis of their own academic criteria
and unique institutional milieu.

Program evaluation and
refinements

At the conclusion of each program
year, MISP staff solicits and analyzes
program evaluations from all under-
graduate, graduate students, and fac-
ulty participants, and they meet with
program partners—Mayo Clinic’s
intellectual property development
office, Medtronic Foundation, and
Minnesota Private College Coun-
cil—to assess program efficacy and
participant feedback. Evaluations are
typically very positive. For example,
when asked “How much value does
The Mayo Innovation Scholars Program

The Mayo Innovation Scholars Program add to your students’ personal and academic development?” all 24 faculty advisors in 2011 responded with the maximum score (5.0 on a 1-to 5-point scale). Undergraduate students gave similarly high marks when they were asked about their “overall satisfaction with participating in the program” (4.8 ± 0.4, mean ± SD, on a scale of 5), and several students responded to the effect that it was the highlight of their college career. From this annual assessment and analysis, program directors continually refine the program each year to enhance the student experience.

In 2011, 154 alumni of the program were surveyed. There were 129 respondents (83% response rate). When asked “In general, how do you rate the impact of your participation in the MISP on your undergraduate experience?” 77.5% of respondents chose “Very high impact” or “High impact.” Frequently in the comments section, alumni talked about how their experience was a key point in their job or graduate school interviews. For example, one alumnus stated, “This program was an amazing experience. The amount of research, and ultimately the presentation, was the focal point of my interviews when I was job searching.” Another commented, “This was a very ‘real-life’ experience and showed me that there is a lot more I can do with my biology degree than become a doctor.” Similarly, to the question “Was your participation in the MISP one of the highlights of your undergraduate experience?” 92% of respondents stated “Yes.” One participant stated, “It continues to be a significant differentiator between me and other candidates when interviewing for new positions.” Another alumnus said, “This unique opportunity helped hone my analytical research skills as well as presentation skills.”

The MISP has also established a LinkedIn group to provide networking opportunities for individuals who have been associated with the program. More than 280 individuals currently belong to the group, and we expect this social medium to facilitate long-term evaluation of the program in the future.

Conclusion

MISP is an original model for practices in science education that are interdisciplinary, challenging, and applicable to real-world discoveries. This program not only exposes undergraduates to the very latest ideas in biomedicine, but it also fosters scientific literacy and communication skills across disciplines in science and business students alike. Today’s students must be able to navigate smoothly across traditional disciplinary boundaries and be able to use their expertise to explain complex ideas to lay audiences or people with different areas of expertise so that they may emerge as tomorrow’s leaders in science, medicine, and business. This program provides students with opportunities to develop these skills, opens their eyes to intersections of diverse disciplines, and helps them think about opportunities that exist for them beyond graduation.

References


John J. Pellegrini (jjpellegrini@stkate.edu) is a professor in the Department of Biology at St. Catherine University in St. Paul, Minnesota. Elizabeth Jansen is a visiting assistant professor in the Department of Biology at Macalester College in St. Paul, Minnesota, and serves as Academic Program Director for the Mayo Innovation Scholars Program.

Appendix

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