

Mentoring Students in Professional-Quality Science Communication

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Students majoring in science often believe they can escape the intensive writing and presentations that their peers in the humanities and social sciences must do. However, science is a collective human endeavor whose success hinges upon effective communication, both written and oral. Even if findings are ground breaking, they are potentially worthless if they can't be shared with others in a clear and engaging way. Teaching undergraduate science students to effectively communicate is therefore an essential goal. Kalamazoo College has utilized Howard Hughes Medical Institute (HHMI) funding to enhance the student research experience and then capitalize on that enhanced experience by integrating science communication into the core and advanced curriculum. Faculty encourage students to think like scientists, conceive of research projects as narratives, and determine the best way to use data to tell a story in written or oral form.

All Kalamazoo College students complete a Senior Individualized Project (SIP) prior to graduation, which has been a requirement since 1962. From their first moments on campus, students know that they will write a senior thesis based on a long-term independent project. Having that goal in mind gives them something to aim for as they develop their research, writing, and presentation skills. Typically, a science SIP entails undertaking a research project during the summer before the senior year, and then writing a thesis and presenting research findings at a departmental symposium or seminar. In addition to the experience of immersing oneself in scientific research, the SIP provides an occasion for intensive writing and public presentation. Ideally, by the time they are seniors, students have developed their writing and presentation skills to a point where they are capable of producing a stellar thesis and riveting talk without extraordinary measures being required of them or their faculty mentors. For some students, this is certainly the case. But others find themselves for the first time facing their writing and presentation demons in a very substantial way.

Writing the SIP thesis, and in many departments presenting it formally, constitutes a rite of passage for Kalamazoo students, and faculty in all departments invest significant time

into mentoring students through the writing and revision process. The Biology Department, in particular, has devised a purposeful developmental progression beginning in introductory core courses and culminating in the formal presentation of SIPs at the annual Diebold Symposium. The SIP and the Diebold Symposium serve as an organizing motif for the major; throughout the curriculum, faculty use the SIP and its presentation at the symposium as the goal toward which they move students.

The developmental progression begins in the laboratory portion of *Evolution and Genetics*, the first introductory course in the biology sequence. Here, faculty focus on the basics – data gathering, figure production, and figure legend writing – which gets students thinking in terms of data communication. In *Physiology and Ecology*, the second core course, the writing exercises are expanded, with more focus on narrative and explaining the rationale behind the completed experiments. Faculty members give students careful feedback not only on the content and data analysis found in their weekly lab reports, but on the writing style and mechanics as well. Recently, HHMI funds were used to hire a new faculty member who has intentionally built upon this early student exposure to science communication. In his intermediate core course, *Cell and Molecular Biology*, teaching labs engage students in a quarter-long research project and the writing expectations are raised yet again. Instead of weekly lab reports, students turn in their analyzed data and receive feedback from the instructor. At the end of the term, students write a manuscript-style paper based on data they have gathered. The instructor describes this final paper as a “mini-SIP,” which prepares students for the full-length SIP thesis they will write later and introduces them to the process of preparing manuscripts for publication. This exercise helps students understand the formulaic nature of science writing and prepares them to think of a series of experiments and results as a narrative whole.

Development of oral presentation skills begins at the intermediate level with a journal club presentation completed by all students in *Cell and Molecular Biology*. Further instruction occurs in more advanced biology courses, several of which

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Students gather in the Biology atrium for a thesis review led by Dr. Moore. From left to right: Tania R. Iqbal, Rebecca K. Tonietto, Daniel H. Russell, Professor D. Blaine Moore, Jacob Januszewski, Lauren M. Yagiela, and Celeste M. Karch.

have a significant or sole primary research focus with multiple opportunities for students to practice science communication. Peer review is often used to encourage open and constructive criticism and to offer suggestions for improving presentation skills. For junior and senior majors, exposure to journal-club style courses with significant presentation components helps to further hone their oral communication skills and leads logically into the Diebold Symposium.

Consistent exposure to science communication throughout the biology curriculum lays the groundwork for writing the SIP thesis and presenting SIP findings, but most of the preparation for these culminating senior year activities occurs in the *Biology Senior Seminar*. The *Biology Senior Seminar* is spread over the junior spring and the fall, winter, and spring of the senior year. Students may apply the one course credit earned through the seminar in any term of the senior year, and the seminar grade is recorded in the senior spring. The *Biology Senior Seminar* functions in large part as a “housekeeping” course, attending to matters such as preparing juniors for SIP research through literature reviews and

critical discussions of pertinent papers and guiding seniors through the revision of their SIP theses and the development of their symposium presentations. The *Biology Senior Seminar* is taught by a member of the biology faculty, with faculty members taking turns teaching the seminar each year. The instructor is responsible for the content of the seminar, assignment of peer review groups for thesis revision and presentation preparation, and for the organization of the Diebold Symposium.

During the spring term, when the seminar is populated by both junior and senior majors, the junior majors work with their senior classmates to help them practice for, organize, and run the SIP symposium. Juniors receive the *Biology Senior Handbook*, which lays out in detail expectations for the SIP thesis and oral presentation. These experiences in the junior spring provide a dry-run of sorts for the senior year and make it clear to junior majors what it is they should be aiming for as they embark upon their SIP research that summer.

The first order of Seminar business in the senior fall is the

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revision of SIP theses. Although SIP theses end up as respectably written scientific documents, they frequently do not appear that way when students return to campus with an early draft of their SIP research findings. These students, who the previous spring had helped their older classmates prepare their SIP presentations, now begin the hard work of revising their SIP theses. Each senior major is assigned to a Thesis Review Team, consisting of three to four senior classmates and a faculty member. The Thesis Review Teams are the primary vehicle through which students write and revise their theses. Organization of the Review Teams occurs in the context of the Senior Seminar, and student participation in the Review Team is graded and contributes to the overall mark in the course. Peer reviewers rely on the *Biology Senior Handbook*, found online at <http://www.kzoo.edu/biology/BiolHandbook04-05.pdf>, which details the process of writing a high quality thesis and gives clear instructions on how to provide feedback to peers about their writing. Each week, the Review Teams read and critique drafts of SIP theses written by one other student. With guidance from the *Senior Handbook* and the Review Team faculty member, student referees learn editing techniques and strategies for improving the SIP under review. Student reviewers are expected to focus on identifying an explicit hypothesis and clear narrative, construction of well-developed paragraphs containing a topic sentence, use of active voice, and a non-redundant writing style. Student reviewers and the faculty member in charge hand in a summary of their comments to the student author. Students also hand in a copy of their remarks to the faculty member to ensure conscientious editing. This also gives the faculty member on the review team an objective measure of the peer reviewer’s effort and is used to calculate a grade for the reviewers.

Throughout fall quarter, students revise their theses based on feedback from their Thesis Review Team. Over the winter holiday, students make final revisions before turning in their completed theses to be graded by faculty. Through this process of revision and peer review, students learn that “writing is re-writing”, and that this level of commitment is what it takes to produce journal-style writing while improving the quality of their SIP theses. In the winter term, as faculty begin the work of grading SIP theses, students turn their attention to preparing for the Diebold Symposium in which they will present their SIP findings to the Biology Department and the rest of the campus community.

For the past 23 years, the Biology Department has held the

Diebold Symposium, a scientific meeting named in honor of Frances Diebold, a legendary member of the biology faculty for 44 years. The symposium, which is modeled after a professional conference, includes a keynote address, two oral presentation sessions on a Friday afternoon and Saturday morning, and a poster session on Friday evening. The symposium concludes with a celebratory dinner for all senior biology majors, faculty, and staff at a local restaurant.

Peer review is used extensively in preparing for “Diebold” as well. The *Senior Seminar* instructor assigns each senior a new group of referees, consisting of at least two senior majors and two or three junior majors, with whom to practice their presentation. Involving juniors in peer review indoctrinates them into the process that they themselves will go through the following year. Practice sessions are scheduled by the students and offer a chance for the review teams to constructively critique the student’s oral or poster presentation, ensuring conciseness and clarity. To encourage a serious team effort, the symposium grade received by the presenter is given to the senior peer referees as well and becomes part of their seminar grade. The grade for the Diebold Symposium presentation is assigned by two faculty members who independently grade the presentation and then reach a consensus as to the final score.

The Diebold Symposium is organized and run almost entirely by the students. All senior and junior majors are assigned to one of three committees, which together accomplish the work of mounting a first-rate scientific conference. Students on the Program Committee determine the order of the presentations, prepare the abstract book, and print the program, while the Local Committee takes care of catering, dinner reservations, and the smooth running of the banquet. Finally, the Graphics Committee oversees the preparation of slides and the printing of posters. In addition to helping each other prepare for Diebold, referees also play an important role during the symposium. Referees introduce speakers, operate room lights according to the needs of the presenter, and ensure that the computer or slide projector functions properly. They are also responsible for keeping the speaker to the 25-minute time limit. Faculty expectations for Diebold are spelled out in the *Biology Senior Handbook*. These guidelines include everything from how the speaker is to be introduced to the most effective ways of presenting data to an audience.

Through the experience of preparing for, organizing, and

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participating in the Diebold Symposium, students gain confidence as speakers while learning the ins and outs of hosting a scientific conference. As a result of their involvement in all aspects of the symposium and because they have worked so hard preparing for the experience, many students consider the Diebold Symposium to be the capstone of their career as biology majors. Diebold is a much-anticipated culminating event for students and faculty alike that showcases and celebrates the impressive achievements of senior majors after four years of a demanding and engaging science education.

Though the Diebold Symposium has been in place for over 20 years, the Thesis Review Teams were established about seven years ago. Before that, seniors returned to campus with a “final” version of their thesis, which faculty would read once and grade. Only theses with egregious problems were handed back for revision. The Thesis Review Teams were developed to improve the quality of the theses overall and to mentor students in how real science writing is done. Because scientists typically share manuscripts with colleagues for feedback on content as well as form, the biology faculty felt that a peer review element for SIP theses was important. With peer review already an integral part of preparation for the Diebold Symposium, it was easy to adapt that model for revising the SIP theses.

Students have responded well to the Thesis Review Teams. At first, some students, anticipating a superficial copy edit, are surprised by the deep revision faculty expect, but they usually rise to the occasion. Students find that they not only benefit from feedback they receive on their theses, but they also learn through the experience of *giving* feedback. The process of carefully reading and thoughtfully commenting on a peer’s writing stimulates thinking on how to improve their own writing.

Many of the current members of the faculty are too new to have experienced the pre-Thesis Review Team days, but those who do remember say that the quality of the theses has improved. The implementation of the Thesis Review Teams went smoothly for the most part. In the beginning, there was a drop in the quality of some of the first theses drafts because students were no longer seeing the thesis they brought back to campus as a final draft. Faculty quickly addressed this problem by immediately returning theses that they deemed not ready for review. They also made it clear that to earn honors on the thesis, the draft submitted for review had to already be in good shape with little or no revision necessary. Faculty put in several more hours now

than they did before, but they consider this time well spent given the benefits to the students and the enhanced quality of the theses.

More changes will likely be made in the biology curriculum to further improve student writing. For example, the faculty is currently considering encouraging more re-writing in core courses by having students submit multiple drafts of lab reports. Faculty workload, naturally, is a concern; one idea is to employ well-trained seniors as grading TAs in the core courses, again taking advantage of the benefits of peer review. However this is ultimately accomplished, the earlier investment in the development of student writing will ultimately pay off with higher quality SIP theses.

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Dr. Moore joined the Biology Department in 2001 when he was hired to fill the HHMI-funded position in neuroscience. Dr. Moore serves on the HHMI program committee and contributed to the 2004 HHMI proposal. He has also served as a mentor to an HHMI scholar.

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