Geology Department
Bowdoin College
Brunswick, ME
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Bowdoin is an independent, nonsectarian, coeducational, residential, undergraduate liberal arts institution founded in 1794. It is located in Brunswick, Maine, a town of 22,000 on the Maine coast. Study at Bowdoin leads to a bachelor of arts degree in one of about 40 departmental and interdisciplinary majors. Bowdoin enrolls approximately 1,625 students from across the country and around the world.

While geology was first taught at Bowdoin in the early nineteenth century and many Bowdoin students have gone on to distinguished careers in the geosciences, the department first granted a geology degree in 1991. For thirty years Emeritus Professor Arthur Hussey was the sole member of the department until in 1986 Ed Laine joined the department, as Director of Environmental Studies. In 1988, Peter Lea joined the department to support the Arctic Studies Program. All three members of the department were first housed under the same roof, a state-of-the art science facility in 1997. With Art Hussey's retirement in 1997, Rachel Beane joined the department. In addition we have a two master's level laboratory instructors, Joanne Urquhart and Cathryn Field.

As we have built a department over the past six years, we focused on pedagogy and improving our teaching and research instruction. In the past year all three faculty have been publicly recognized by the college for our excellence and innovation in these areas.

- Why is your department valued by your institution?

One primary reason our department in valued by Bowdoin because we have created three introductory courses that are viewed as *open*, *engaging*, and *challenging*. Each faculty member teaches an introductory course that can count towards the major, but is chiefly populated with students meeting the Inquiry in Natural Science Requirement. Each course has as its basis field research in the local area with themes of either bedrock geology (Rachel Beane), hydrology (Peter Lea), or oceanography (Ed Laine). Each course uses a field-based, hands-on approach to geoscience. Each has a lab course with regular field trips, and each has a project component in which students work in small groups on true research projects (i.e., the precise outcome is not known ahead of time, even to the instructors). Course enrollments are capped at 36 (two lab sections) and are well-subscribed.

Our courses are viewed as open because the quantitative side of science is primarily delivered by field research through which students develop ownership of their data. Students acquire and develop quantitative tools of science as they pursue answers to questions that actively engage them. We have neither expressed nor implied pre-requisites for our introductory classes.

We consciously build and maintain community in each of these courses, finding that the safer and more open learning environment that results from this effort encourages greater intellectual engagement. On campus students recognize this openness and it is one

reason our enrollments have been robust. Students come to Bowdoin expressing a wish to engage in collective activity such as athletic teams, community service, and social organizations. That our classes provide an academic outlet for this clearly expressed desire is viewed favorably by the administration.

Our classes are engaging because each has a primary basis in field research. Doing science is a significant component of each course. Set labs and field exercise are aimed at building the capacity of our students to carryout research projects. Significant dialog in the classroom, the topics in lectures/labs, as well as most writing and reflection exercises occur in pursuit of answers to questions raised by field research projects.

Many students come to Maine because of its location and these courses allow them to become intellectually engaged with the rocks, sediments, and waters of coastal Maine. Two of the courses are focused on local environmental problems through either community-based or problem-based service-learning. The chance to engage with community partners furthers our students' intellectual engagement with course material. Service-learning courses in particular seem to engage woman students. Over the past 5 years 63% of the students in our service-learning-based introductory oceanography course have been women.

Students are intellectually engaged in our introductory courses because we introduce them to many of our research tools. Introductory students work with our SEM/EDS/EBSD, Seabird CTD, RF ADCP, and aboard our small research vessel. We use ArcGIS, MS Excel, and MS Publisher in our labs.

Our courses are viewed as challenging because they provide realistic field research. Students are asked to address geological, environmental, and oceanographic problems whose outcome is not known. Initially they must learn enough science to understand the problem and enough about field technique and instrumentation to design with guidance an adequate field program. After they have designed and carried out their field program, they are encouraged to reflect upon their initial results and perhaps carryout out further observations if they are needed. With data in hand they are then challenged to acquire quantitative skills to analyze their data. From there they have to write/rewrite reports, make public presentations, and in many cases high quality posters. We find that such an approach successfully teaches the value of scientific inquiry, inductive reasoning and discovery, while exposing students to field observations and analytic and quantitative analysis.

- What is the nature of your students' community in the department?

Our emphasis on project work has led us to actively build and maintain community in our classrooms. When students feel safe in our classrooms they become more comfortable in their roles as active learners. When confronted with difficult or unfamiliar concepts they ask for help from each other and get explanations from their peers.

Students serving as TAs in our introductory courses, departmental assistants, and students doing research projects have office space in the department. TAs often have office hours during the evening, volunteer to run review sessions before exams, and assist introductory students with their projects and posters. Giving our majors both space and responsibility is a signal to them the importance we place on intellectual endeavor,

our recognition of their hard won academic achievements, and our value for them as individuals.

- What is the common vision the faculty share for the department?

We are bound together by a passion for pedagogy and for improving our teaching and research instruction. All three of us have embraced a field-based, hands-on, inquiry-based approach to our teaching and have found differing ways to express our commitment. Peter Lea does community-based learning in which he involves his students in environmental/hydrogeological projects of community importance. He has adopted a vertically-integrated approach that involves selected junior high schools throughout the state in the discovery process. Rachel Beane has adopted an approach to bringing research into the classroom that uses the rocks of Casco Bay as her natural laboratory and which allows students to carryout their inquiry using state-of-the-art equipment such as a SEM/EDS/EBSD. Ed Laine uses service-learning as a method of connecting his students with community partners with environmental/oceanographic needs/problems in Casco Bay.

We operate by consensus and try to share the work load equitably.

- How do the faculty collaborate to achieve this vision?

As we came together as a department in the late 90's, our collaboration started with extensive sharing of methods and approaches to teaching. We talked about what works well and supported each other with ideas on how to approach vexing problems. Initially we would meet all day at the end of the semester to discuss and analyze our successes and failures. Over time such discussion has become part of the department culture and our meetings in this regard are less formal.

Having such a clear vision of where we want to go has made it easy to speak with a clear voice to the administration. We analyzed both the resources and training we needed to achieve this vision and have had a consistent policy in approaching the administration to achieve our goals. When the college has not been able to move quickly enough, we have sought outside funding from NSF and private sources. In addition to adding to our inventory of equipment and instrumentation, external funding has added to a service-learning coordinator/laboratory instructor to our staff

We also have been willing to experiment with new approaches. Much of our progress in Information Technology (IT) has come because we are known as a department with a clear vision and a flexible attitude. We have stayed at the crest of the IT wave *at Bowdoin at least,* because we have been willing to try new technologies before they are rolled out elsewhere on campus.

- What makes your curriculum strong and aligned with the needs of the students, faculty, and institution?

Our graduates are able to get into very competitive graduate schools. Others find entry level positions with environmental consulting firms or with the USGS. Students who do not do summer research on campus find interesting and challenging work, in some instances leading to independent study or thesis work when they return.

We believe that our success in this regard is due to adopting a curriculum that fosters problem-solving and inquiry. In addition, we know that our emphasis on training our students with state-of-the-art tools is a door opener. For example, students compose their resume around the projects they have worked on instead of the courses they have taken, citing or even including reports they have given to community partners, emphasizing skills they have acquired, and demonstrating their communicative abilities. Being able to talk about a student in these terms makes it very for us easy to write letters of recommendation or do phone interviews, even for first year students who have only completed an introductory course.

Many of our students come to Bowdoin expressing a desire to be in the outdoors and learn about Maine. They also express a need to connect to the community and give service. Our curriculum allows them to do all these things and to reflect upon their experiences in an academic context.

As faculty, our curriculum allows us to do the same things. Every week we have many opportunities to continue to learn in an inquiry-based mode. We get out into the field and explore Maine and we connect to our community. Our emphasis on state-of-the art software and hardware makes us keep abreast of new developments. Our emphasis on curriculum and pedagogy leads us to learn what others are doing outside the college. The college recognizes our efforts publicly and we work with faculty both inside and outside the institution to help them improve. Rachel Beane and Ed Laine were recently chosen as mentors for new faculty. Ed Laine consults throughout New England on service-learning for the Campus Compact.

Adopting an inquiry-based curriculum has altered our role as teachers. Instead of just delivering canned lectures, frequently we arrive with "just in time" material, suited to the needs of students as they struggle with their projects. We are no longer the distant custodian of knowledge: we have become mentors of life-long learning habits. Several years ago, instead of adding a new laboratory instructor, we added a service-learning coordinator/laboratory instructor, Cathryn Field, whose job description includes working with community partners to create strong, reciprocal partnerships.

The college has recently gone through a thoughtful examination of required courses and has reorganized this part of the curriculum around a model of "modes of inquiry". Our inquiry-based curriculum, especially our introductory courses, is viewed as a model for how to deliver courses satisfying the Inquiry in the Natural Sciences requirement and as a model for how all sciences might refocus their energies.

• What other departmental activates (e.g. research, recruiting and mentoring students or faculty, field trips) are important in making your department, your faculty, and your students successful?

Important to our success has been a new science building whose design fosters our new curriculum. We now reside in a building that was completed in 1997 and share this facility with Biology and Chemistry. Three years ago our space went through a

major series of alterations which were improvements. In both instances we worked very carefully with our architects to design a space that would allow us to comfortably achieve our vision of an inquiry-based curriculum. Faculty and staff offices as well as student spaces were designed to foster communication and collaboration. Many of our labs are designed to be used flexibly and to serve several roles during a single semester.

Rachel Beane's efforts have allowed the college to acquire an SEM/EDS/EBSD through a combination of NSF and college funding. This instrument package is managed as a shared facility used by the sciences, Classics (metallurgy of ancient coins), and Anthropology. Broad use of the facility throughout the college has led to technician support within the department and a comprehensive service contract supported by the college.

In years past Peter Lea and Ed Laine have accepted significant administrative activities in areas important to the goals of the college. Peter was the first Director of the Coastal Studies Center and helped establish this facility as a show piece of multidisciplinary endeavor for the college. Ed Laine was Director of Environmental Studies (a coordinate major) for over a decade and helped build ES into a popular program that at times includes 15-20% of the majors on campus. Their efforts, like those of Rachel Beane with the SEM, have linked the department formally and informally with departments throughout campus, enriching and informing all in the process.

Finally, we have actively mentored research students during the semester and especially during the summer. Using a combination of grants and college funds we have regularly have ten or more students in residence during the summer. Some are working on thesis work and others have just completed their first year and are learning the ropes.

Conclusion

Key to our success has been an intense focus on pedagogy. Adopting a field-based and inquiry-driven curriculum influenced most of the decisions we have had to make. The strong faculty and staff consensus behind this pedagogic focus allowed us to clearly state our needs both within and outside the college.