In the Oceanography Classroom

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WHAT IS THE PURPOSE OF THE Ph.D. DEGREE PROGRAM?

More than one department is currently reviewing its Ph.D. degree program in oceanography. The basic question of such a review is: what is the purpose of the program? I think we would agree that the most basic answer to that question is that the Ph.D. program prepares students to be oceanographers. More specifically, we might say that students are expected to demonstrate proficiency in the craft of inquiry by successfully completing original research projects and writing the descriptions and results of their work as dissertations that are intended for reading by scientists in the students' specialties. We might elaborate that, in order to achieve this distinction, the students must have accumulated sufficient knowledge within their specialties to set the context for their research. They must also have gained sufficient practice in appropriate inquiry and thinking skills to enable them to represent the research problem in a soluble formulation and to obtain the necessary information in the proper form for them to reason their way to an acceptable solution. I submit that this is not an unreasonable statement of what has commonly been expected of students in order to receive a Ph.D. degree. They become the oceanographers of the future. They continue the discoveries; they inform us about new findings; they apply those findings for the benefit of society. The next question is whether this is how graduate students should learn to become oceanographers today. And the answer to that question depends in large part on what oceanographers do today.

Research is changing. Even the names of oceanographic disciplines are changing. Old disciplines such as "marine geology and geophysics" are elevated to a category of new disciplines. New disciplines such as "marine biogeoscience" and "ocean mantle dynamics" are created with broader or narrower subject matter content and with new methods of inquiry that are so much more varied or probe so much deeper that more and more research questions must be framed in breadth or depth for solution by groups of scientists rather than the solitary Ph.D. scientist. "Interdisciplinary teams," we hear that term often, recommended with the certainty of experience. If a purpose of graduate education is now for students to learn the craft of inquiry in interdisciplinary research, then the description just given of Ph.D. education is sadly incomplete, for this description is of a solitary student preparing to enter the community of oceanographers and work alone.

If new Ph.D. oceanographers are to contribute to a community of oceanographers that consists of interdisciplinary teams, created for various lengths of time to solve various oceanographic problems and then disband (though in academia breaking up is hard to do), then should not their graduate education encourage their learning and practice as members of a team? This statement is not intended to depreciate the importance of specialization. Joel Shulman, Manager for External Relations, Research, and Development at Procter and Gamble Company, captures the need for both depth and breadth aptly when he speaks of industry's desire for Ph.D. scientists who are educated to a "T," for "technical competence." That is, they have demonstrated the ability both to attain a great depth of knowledge in their specialties and to connect a relatively shallow breadth of knowledge across other disciplines, a connection that sets their own specialties in a broader perspective and introduces them to the content and culture of other disciplines.

Paraphrasing John Seely Brown, Chief Scientist of Xerox Corporation and Director of the Xerox Palo Alto Research Center: if this learning is accomplished in a "community of practice", in which students can learn from one another and the professor while learning the way a particular science is practiced, they are more likely to understand both the subject matter content and how scientists talk about the practice of that discipline. They will thus be better able to collaborate in an interdisciplinary team by being prepared to listen to the way other team members talk about their disciplines, to attend to the different attitudes toward information that may characterize other disciplines, to mold their own expertise into the composite expertise required for the research problem, and to develop a team identity. These interpersonal skills have both a generic component and, as noted by Shulman, a discipline component. Think how different the application of these same skills would be in collaborating with seagoing observational oceanographers, numerical modelers, or K-12 science teachers.

Brown and Shulman remind us that the other skill required for successful collaboration is communication. But proficiency in this skill requires more than the ability to transfer information. It requires an appreciation of what the other members of the team need to know. Being able to communicate in this technical fashion is explained lucidly by another Shulman, Lee Shulman, President of the Carnegie Foundation for the Advancement of Teaching, to mean knowing one's science so well in depth and in breadth of context that one can teach other people to understand the part of the science content, methods, and findings that is relevant to the research project, even though the other people are not specialists in that science. Thus, "technical communication" is, at its core, "teaching."

I have drawn from Joel Shulman's and John Seely Brown's ideas, in part, because they are cogently presented–though my paraphrasing does them little justice-but also because we should recognize that industry is redefining the purpose of graduate education in research-intensive institutions. Even so, it is true that most Ph.D. students in oceanography take career paths into academia, many of them following paths into teaching-intensive institutions. By definition, teaching is the major responsibility of faculty in teaching-intensive institutions. Consequently, these institutions are also redefining the purpose of graduate education: to be prepared to teach, their future faculty should know more than just the subject matter content of a discipline. That graduate students are not prepared to teach undergraduate students the concepts, connections, and applications of their science is bemoaned by administrators in teaching-intensive institutions and by many of those graduate students. Ironically, the unlearned teaching strategies include the active learning strategies used to teach other members of a research team.

If the purpose of a Ph.D. program is to prepare graduate students to be oceanographers and do what oceanographers do, and if I have accurately sketched out what oceanographers are expected to do today, then it would seem that a Ph.D. program should enable students to learn how to investigate the ocean, to integrate knowledge across disciplines, to provide the service of their science to others through collaboration, and to teach others (communicate) their science. Stated thus, the purpose may seem little changed from what most of us experienced as graduate students, but let's look more closely.

Graduate students are well prepared through their research experience to undertake the "investigation" of the ocean in their specialties. This preeminent expression of the faculty's scholarship is the strength of graduate education. Faculties have little difficulty assessing their degree programs with respect to this purpose. One way to determine whether students are also able to integrate knowledge across disciplines is to assess their ability to think in terms of "big ideas" that span disciplines. Faculties have puzzled over the familiar phenomenon of their students scoring high on class examinations but low on general integrative examinations. The answer may well lie in the students having taken from the classes little integrative knowledge or skill. Another test of integration is the ability of students to place the results of their own research in a broader intellectual perspective. Students will be able to provide the service of their science to others through collaboration only if they have practiced the skill. Does the program provide them with opportunities to practice, particularly with people outside the dissertation advisor's research group? We should note that expectations for collaboration with K-12 teachers and informal educators is increasing, because the core audience waiting to be taught about the ocean is not the members of research teams but school children and the general public. Finally, have the students had the opportunity to learn how to teach others their science? "Teaching" means knowing one's learners, setting goals, using strategies in addition to lecturing, and assessing student learning. Learning how to teach comes only through practice.

A department might consider developing students' proficiency in these abilities to be the purpose of a Ph.D. program. Such a program would prepare students to be oceanographers–but oceanographers of broader and more flexible abilities than previously expected. Not coincidentally, these abilities are essentially those recommended for faculties by Ernest L. Boyer, the esteemed late president of the Carnegie Foundation for the Advancement of Teaching. But perhaps we think our existing programs adequate. Faculties will debate the need for change, as they commonly do. Perhaps it is not out of place, however, to note that industry, far better than academia, knows the risk inherent in a strategy based on "we've always done it this way and our product has always sold, so don't change it now."