Great Problem Seminars: Engaging First Year Students in Project-Based Learning

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In the early 1970’s, Worcester Polytechnic Institute (WPI) promoted project-based learning to the core of its academic program. At that time, WPI redesigned its graduation requirements to include two required projects [2]. One project is undertaken within the student’s major field of study is completed during the senior year. A second project is usually completed during the junior year and challenges students to work on an interdisciplinary problem at the interface of science, technology, and societal needs [4]. For both projects, effective teamwork is a key skill emphasized throughout.

With this project backdrop in mind, the Great Problems Seminars (GPS) were initiated for first year students in 2007. Like the junior year project, GPS are designed to engage students with current events, societal problems, and human needs. Each seminar focuses on a large global issue. Power the World (PTW), focuses on energy and its utilization. PTW is co-taught by a mechanical engineer and a social scientist (public policy).

The faculty who developed the seminars [3] focused on three key principles:

1. Engage first-year students with current events, societal problems, and human needs in a project and team based learning environment,
2. Require first year students to perform/produce critical thinking, information literacy, and evidence-based writing, and
3. Devote time and attention to nurture the development of professional skills including effective teamwork, time management, organization, and personal responsibility.

While not explicitly patterned after ABET student outcomes [1], GPS shares similar goals, especially in ABET Criteria 3d- through 3j, e.g. the ability to function in multidisciplinary teams and to understand the impact of engineering solutions in a global context.

Our seminars are therefore defined by problems, not by discipline. They are interdisciplinary, not multidisciplinary. The seminar is neither a survey of engineering nor social science fundamentals. Great Problems cannot be adequately framed within a single discipline that offers a single solution approach.

The first half of the two-term Power the World sequence explores the depth and breadth of energy issues. The physics and engineering of energy and power production are introduced. Discussion emphasizes technical solutions, but in a geo-political, socio-economic context. Students meet weekly with the faculty team and also in separate discussion groups to enforce the multidisciplinary nature of the problems. Activities include a model United Nations session to develop nuclear energy policy. Assignments include a literature review of a chosen solar energy problem and a research proposal for each team’s course-long project. Student teams are allowed to choose their own project topics, albeit with faculty guidance, as it is important that students take ownership of the problem.
Class discussion continues in the second term, but the emphasis shifts to project work. Teams of 3-5 students perform an in-depth analysis of some aspect of the problem, and try to frame a partial solution based on their investigations. Successful project teams demonstrate fluency in analyzing a technical component, as well as awareness and assessment of the social, political and economic circumstances of the problem.

Mileposts include: midterm and final oral presentations to the class, weekly progress drafts, a substantive final written report and a poster presentation open to the public (includes 200+ students in the various GPS). Topics have included:

- Evaluation of cost effectiveness of geothermal heating systems in New England,
- A comparative analysis of policies regarding new nuclear facilities,
- Electric vehicle infrastructure in Massachusetts,
- Use of solar energy in third world countries for electricity and water pumping,
- Piezoelectric energy harvesting

Focus group assessment demonstrates that the GPS courses achieve the original objectives. Student course evaluations indicate high satisfaction despite requiring significantly more work than the traditional first year disciplinary offerings. Students found the key benefits to be in presentation skills and team working skills. Alumni of the class have reported greater confidence in speaking, team leadership, and dealing with those in authority. Students approach their junior and senior projects with greater confidence. They find themselves asking broader questions and are able to think of problems in a broader context.

The Great Problems Seminars were designed as an experiment to bring WPI first year students into meaningful contact with current events, societal problems, and human needs. Using global issues as a backdrop, seminars are co-taught by an interdisciplinary pair of faculty to explore the depth and breadth of the problem and to focus on active learning and group projects to link societal needs with technical solutions. Assessment demonstrates that the GPS courses achieve the original course objectives and that students clearly value how these courses prepare them for their futures.


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