Long-term Impacts of Project-Based Learning in Science and Engineering

Prof. Arthur C Heinricher, Worcester Polytechnic Institute

Arthur Heinricher is Dean of Undergraduate Studies and Professor of Mathematical Sciences at Worcester Polytechnic Institute. Dr. Heinricher joined the faculty of WPI in 1992, with a B.S. in Applied Mathematics from the University of Missouri-St. Louis and a Ph.D. in Mathematics from Carnegie Mellon.

His primary responsibility as Dean of Undergraduate Studies is to assess and ensure the quality of undergraduate programs at WPI. He helped guide the development of WPI's Great Problems Seminars engaging first year students with interdisciplinary projects tied to problems of current, global importance. He served as Director of the Center for Industrial Mathematics and Statistics at WPI and worked with more than 100 students on more than 30 different mathematics projects with business and industry. He was also principal investigator on WPI's Research Experience for Undergraduates in Industrial Mathematics and Statistics and was co-organizer of the Mathematics in Industry Institutes for High School Teachers at WPI.

Paula Quinn, Quinn Evaluation Consulting

Paula Quinn is an independent evaluation consultant with Quinn Evaluation Consulting. She specializes in the field of education and has worked on projects funded by the National Science Foundation, U.S. Department of Education, state departments of education, and private colleges and universities. She holds an M.A. in Developmental Psychology from Clark University and a B.A. in Psychology from Case Western Reserve University.

Prof. Richard F. Vaz, Worcester Polytechnic Institute

Richard F. Vaz received the PhD in electrical engineering from Worcester Polytechnic Institute (WPI), specializing in signal analysis and machine vision. He held systems and design engineering positions with the Raytheon Company, GenRad Inc., and the MITRE Corporation before joining the WPI Electrical and Computer Engineering faculty in 1987. Rick is currently Dean of the Interdisciplinary and Global Studies Division at WPI, with oversight of WPI's Global Perspective Program, a worldwide network of 35 Project Centers to which more than 600 students per year travel to address problems for local agencies and organizations under faculty supervision. Rick also oversees the Division's academic unit, which focuses on local and regional sustainability in support of WPI's interdisciplinary degree requirement.

Rick's teaching and research interests include service and experiential learning, engineering design and appropriate technology, and internationalizing engineering education. He has developed and advised hundreds of student research projects in the Americas, Africa, Australia, Asia, and Europe. Rick has published over 55 peer-reviewed or invited papers and is the recipient of numerous teaching and advising awards including the WPI Trustees' Awards for Outstanding Teaching and for Outstanding Advising. From 2004 to 2010 he served as a Senior Science Fellow of the Association of American Colleges and Universities.

Prof. Kent J Rissmiller, Worcester Polytechnic Institute

Associate Dean, Interdisciplinary and Global Studies Associate Professor, Social Science and Policy Studies

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Abstract
Long-term impact of formal project work for science and engineering alumni from Worcester Polytechnic Institute was studied through an externally-conducted web-based survey. The survey included 39 Likert scale questions targeting impacts grounded in 1) institutional undergraduate learning outcomes and 2) areas of unanticipated impact that emerged from a pre-survey online ideation exercise. The survey was distributed to over 10,000 randomly-selected graduates and had a response rate of 25%. Results showed that project work had long-term positive impacts on alumni in terms of professional skills, world views, and personal lives. Mann-Whitney *U* tests revealed statistically significant differences: Project work had stronger positive impacts on engineering majors when compared to non-engineering majors and on alumni who completed off-campus projects when compared those who completed on-campus projects. Kruskal-Wallis tests identified areas where impact either changed or remained stable over time. Findings provide a unique perspective on the long-term impacts of project-based learning.

Introduction

This paper provides an overview of an evaluation study of the impact of formal project work for students who graduated from Worcester Polytechnic Institute (WPI) in science and engineering majors between 1974 and 2011. WPI has featured a project-based curriculum since the early 1970's. While there have been many studies of the impact of project-based learning (PBL) on student engagement, student retention, and student learning, we know of no other attempt to study the impact of PBL over such a long time period. The population surveyed included alumni who were students when Richard Nixon was president and used a slide rule for homework and exams. It also includes students who graduated while Barack Obama was president and have always had a calculator on their smartphone. It includes graduates with almost 40 years of career experience as well as graduates in their first year on the job.

All of the alumni surveyed completed at least two significant projects during their undergraduate studies. Both projects were required for graduation and neither is part of any traditional course or classroom experience. Each of the projects carried 9 credits or roughly one quarter of the credit for one academic year.

The survey was developed and implemented by an external evaluator. It included questions defined by WPI's undergraduate learning outcomes (ULOs) as well as questions that grew out of an ideation exercise with a stratified sample of alumni. The small sample of alumni who participated in the ideation exercise highlighted personal and professional impacts, such as strength of personal character, which the faculty had not identified as a goal for the educational program.

We emphasize that this is an *evaluation study*, not a research study. Our goal was not to test hypotheses regarding the impact of project-based learning relative to other educational approaches but to empirically investigate the merit, worth, and value of the program using

methods and approaches from the social sciences.[1] The summary presented here will provide an overview and highlight what we believe are some of the most interesting patterns in the response data. In almost every case, the patterns indicate areas for future research.

Background

In his introductory editorial to the April 1997 issue of the Journal of Engineering Education[2], John W. Prados called for "a totally new engineering education paradigm…built around active, project based learning." This view was clearly connected to the shift ABET made at that time toward outcome-based assessment for engineering education. More recently, the National Academy of Engineering[3,4] continued the call for reform. It has also increased the focus on education with a clear purpose in its definitions of the Grand Challenges for Engineering[5,6]. A 2012 NAE report[7] on real world applications highlighted 29 exemplary programs, selected from almost 90 nominations from a wide range of undergraduate programs, where some form of real-world project experience is provided to undergraduates.

Project-based learning is certainly much older than these recent calls for reform. One of the oldest definitions was given by Kilpatrick[8] in the 1920's. He described project-based learning (or the project method for education) as *any kind or variety of life experience which is in fact actuated by a dominating purpose* and presented ways to use the project method in the K-12 classroom. The key point was that the problem is engaging and dominates the academic subject being studied.

There is a vast and growing literature on project-based learning in and out of the classroom. Felder[9,10] has been one of the most prolific researchers on the value of project-based learning as a pedagogical approach. See also Dixon[11] for a study of project based learning in foundation courses in chemical engineering. Litzinger[12] presents a thorough study of the wide range of approaches used in and their impact on the education of engineers. The volume edited by Tsang[13] provides several examples of how project-based learning, in the form of service learning, has been used in science and engineering education.

Savery[14] and others[15] point to innovations in health sciences education in the late 1960's as the start of problem-based learning. They also define specific characteristics that they use to distinguish project-based learning from problem-based learning. The key distinction seems to be that the primary goal of project-based learning is the application of knowledge while the primary goal of problem-based learning is the acquisition of knowledge. In practice, and in the form of project-based learning studied here, each project experience certainly lives at some point on the spectrum between pure acquisition of new knowledge and pure application of existing knowledge. Each of the projects considered here are viewed (by faculty and students) as in some sense a capstone experience and so the emphasis is on application of knowledge. Every good project will, in fact, involve both.

All of the alumni in this study graduated from WPI with a Bachelor of Science degree in a traditional discipline of science or engineering between 1974 and 2011. The undergraduate program at WPI was completely redesigned in the late 1960's when a very traditional curriculum was replaced with a project-based program which emphasized the students' ability to apply

knowledge in authentic settings. In fact, the primary graduation requirements were two significant projects:

> ***Project #1: The Interdisciplinary Project***. This project, usually completed in the junior year, asked the student to address a problem at the intersection of science and technology with societal need.
>
> ***Project #2: The Major Project***. This project, usually completed in the senior year, is a design or research project in the student's major area of study.

Each project carries 9 credits, roughly one quarter of an academic year's work. Each project has a faculty advisor working closely with a small team of students (usually 2–4 but sometimes 1 or more than 4). For the major project, the advisor is a faculty member in the appropriate discipline. For the interdisciplinary project, even though many of the projects have aspects of social science research, faculty from all departments serve as advisors.

This is important to emphasize: projects are required for all students and project advising is part of each faculty member's teaching responsibility and is counted in loading models. In addition, the interdisciplinary projects are truly interdisciplinary. Faculty from all disciplines and departments serve as project advisors. There is rarely a connection with the students' majors or the faculty advisor's discipline; both faculty and students explore new ground in the project.

The fact that all faculty are involved is a strength, but this also guarantees that there will be a range of approaches and a range of student experiences in each of the projects. While there have long been both formal and informal systems in place to help faculty develop and improve project advising skills, each advisor takes his or her own approach to the work schedule, feedback to the students, and expectations.

When the faculty developed the project system, a clear set of educational goals was stated. These goals were translated into assessable undergraduate learning outcomes (ULOs) in 2004, as follows:

All graduates of WPI will:

1. have a base of knowledge in mathematics, science, and humanistic studies.
2. have mastered fundamental concepts and methods in their principal areas of study.
3. understand and employ current technological tools.
4. be effective in oral, written and visual communication.
5. function effectively both individually and on teams.
6. be able to identify, analyze, and solve problems creatively through sustained critical investigation.
7. be able to make connections between disciplines and to integrate information from multiple sources.
8. be aware of how their decisions affect and are affected by other individuals separated by time, space, and culture.
9. be aware of personal, societal, and professional ethical standards.

10. have the skills, diligence, and commitment to excellence needed to engage in lifelong learning.

The two required projects were the primary method for measuring student achievement for outcomes number 4 through 10. These outcomes were used to inform the development of the survey, providing the exact work for some of the questions.

Method

Instrument: The ultimate goal of the survey was to gather information on the impact that formal project work had on alumni after they had completed their undergraduate studies. In an effort not to bias alumni, however, this precise intention was not articulated to potential respondents; they were instead informed of a broader intention of the survey: to get a better understanding of the experiences they had as undergraduates.

The core of the survey consisted of 50 Likert scale items. The first 11 core items asked alumni to indicate the extent to which each of the following aspects of their time as undergraduates had affected them after they had completed their undergraduate studies at WPI:

- Length of the academic terms
- Greek life
- Sports/athletics participation (any level)
- Other WPI clubs/organizations
- Humanities and arts courses
- Courses in their majors
- The Interdisciplinary Project
- The Major Project
- Peers at WPI /fellow WPI students
- Relationships with professors
- Travel (WPI-related)

These items relied on a seven-point Likert scale, with response options ranging from "Negatively, Much" to "Not At All" to "Positively, Much," with an additional eighth response option of "Not Applicable."

The remaining 39 core items asked alumni to indicate the extent to which their formal project experience at WPI had impacted their abilities, perceptions, understanding, or development regarding areas relevant to their professional lives, their world views, or their personal lives. Of these 39 items, 24 targeted impact on professional lives, six targeted impact on world views, and nine targeted impact on personal lives. Of these 39 items, 23 are directly relevant to the WPI learning outcomes, and one is directly relevant to a particular goal of the undergraduate program. These items relied on a five-point Likert scale with response options ranging from "Not At All" to "Very Much," with an additional sixth response option of "Not Applicable." Exact phrasing of items can be found in the appendix.

The survey also contained several items designed to gather the following demographic information from respondents: major, year of graduation, sex, current primary place of residence, type of project work completed at WPI, whether project work was completed on or off campus. (The number of items varied, depending on the number of projects that had been completed.) Another item asked respondents if they would like to be contacted by the external evaluator in the future regarding the possibility of participating in a follow-up interview.

The survey was developed by the external evaluator solely for the purpose of this study. Time and budget constraints precluded statistical determinations of either validity or reliability. Findings from an online asynchronous ideation exercise with a sample of alumni stratified for year of graduation, sex, and major informed survey development. The ideation exercise revealed that the formal project work that WPI alumni participated in was a significant and important aspect of their undergraduate experience that had far-reaching implications and impact beyond time spent at WPI. Alumni reported that as a result of their formal project work at WPI, they:

- Received excellent professional preparation
- Developed habits of thoughtfulness and broadness of mind
- Developed a stronger personal character
- Had opportunities expanded
- Enjoyed travel
- Experienced personal enrichment
- Developed insights regarding business and industry
- Felt connected with a community
- Had "real world" experiences

In addition to findings from the ideation exercise, the external evaluator used the following to inform development of the survey:

- Input from a group of WPI stakeholders who attended a meeting during which findings from the ideation exercise were discussed
- A review of items from two instruments that WPI uses in its institutional assessment efforts—the National Survey of Student Engagement (NSSE) and the Engineering Exit Assessment from Educational Benchmarking, Inc. (EBI)
- Feedback from a pilot test of the survey with 16 volunteer students who had been in their senior years at WPI at the time of the pilot

Because a wide variety of relevant sources impacted survey development, the external evaluator and WPI stakeholders believed the final version of the survey had a high degree of face validity. WPI applied for approval from WPI's Institutional Review Board (IRB) to conduct the survey and an exemption was granted.

Recruitment: WPI furnished the external evaluator with a database of graduates from years 1974 through 2011; since the class of 1974 was the first to graduate after project work became part of the curriculum, this was the earliest year included in this study. Of the 21,498 living alumni in the database of graduates from years 1974 through 2011, there were 20,023 who met the following criteria for inclusion into the selection pool:

- Completed at least one formal project at WPI
- Granted "permission to contact" to the WPI Office of Development and Alumni Relations
- Furnished the WPI Office of Development and Alumni Relations with either a ground address or an e-mail address

Not all alumni were accessible via both e-mail and ground mail, however. Given the possibility that differences in the type of contact information that alumni furnish are indicative of differences in attitudes towards WPI or experience while attending WPI, a stratified random sample was selected according to avenues of accessibility.

The number of alumni recruited for each strata was determined through consideration of the following: desired confidence level (95%) and confidence interval ($\pm$3), anticipated response rate (approximately 20%), and recruitment costs. Because no individually-based recruitment costs were associated with e-mail recruitment, a population sample was selected for those for whom only e-mail addresses were available. Because the recruitment approach for each of the strata for which ground addresses were available involved individually-based recruitment costs, a randomly selected sample was chosen from each of these strata. After recruitment efforts began, bounced-back e-mail messages and returned hard copy letters indicated that some of the contact information in the database was no longer valid. Table 1 conveys the stratification of the sample pool, along with the numbers of valid records for each strata.

Table 1. Survey Participants, Stratified According to Avenue of Contact

	Participants				
Avenue of contact	**Number in original database**	**Number attempted to recruit**	**Number with valid contact info**	**Number of responses**	**Response rate (# of responses/ # valid)**
Ground mail only	7033	4696	4624	595	13%
e-mail only*	716	716	516	118	23%
Ground mail AND e-mail	12274	4947	4932 ^	1819	37%
Total	**20023**	**10359**	**10072**	**2532**	**25%**

*Note: This group included alumni who were living outside of the U.S. at the time of the survey. Treating non-U.S.-resident alumni as those who were only accessible via e-mail made recruitment of alumni from this group logistically manageable.

^Note: Of this figure, ultimately ground mail addresses were valid for 4,888 and e-mail addresses were valid for 3,916; there were only 15 alumni in this group for whom both the ground address and the e-mail address ultimately were invalid.

To obtain the best response rates possible, a multi-phased recruitment effort was used for this survey. All randomly selected alumni received each of the following: a pre-recruitment message sent from individuals from WPI that the external evaluator believed would positively influence the likelihood of alumni to participate, a recruitment message sent from the external evaluator, and at least one reminder.

Incentives were offered to alumni to take the survey. A $1 pre-paid cash incentive was sent with hard copy recruitment letters to all randomly selected alumni with ground mail addresses. When e-mail recruitment messages were sent, an offer for entry in a cash raffle (for one of four cash prizes: US $250, US $100, US $100, US $50) was included. Those with both ground and e-mail addresses received the pre-paid cash incentive plus the offer of entry into the cash raffle.

Pre-paid cash incentives were sent to those with ground addresses because research has shown that a recruitment letter mailed with a small cash incentive significantly increases participation in an online survey.[16] Researchers have suggested that a small cash payment increases participation rates because it invokes the norm of reciprocity, a strong social normative standard leading individuals to strive to repay favors freely given.[17,18]

The external evaluator sent three e-mail reminders to all alumni who had e-mail addresses and one hard copy reminder to those alumni who had only ground mail addresses. All reminders (whether sent via e-mail or ground mail) included information on the cash raffle incentive.

Participants: Informed consent was obtained from all respondents. After the survey closed, the data file was reviewed for duplicate records, and three duplicate records were removed.

In all, 2,532 alumni completed the survey. Table 1 shows the response rates for each sample strata and the sample as a whole. Of the 2,532 participants, six indicated that they had not completed either the Interdisciplinary Project or the Major Project, so they were excluded from analyses, yielding a data set of valid records from 2,526 WPI alumni. As a whole, this sample of 2,526 has a confidence interval of $\pm$1.8% at a confidence level of 95%. Of this sample of 2,526 alumni, 2,505 had indicated that they had completed both the Interdisciplinary Project and the Major Project. Of these 2,505, 1,780 (71%) were engineering majors. Also, of these 2,505 who indicated that they had completed both the Interdisciplinary Project and the Major Project, 1,061 (42%) indicated that they had completed at least one off-campus project while 1,444 (58%) indicated that they did not complete at least one off-campus project (i.e., they completed an on-campus project). Additionally, 2,444 of these 2,505 identified their sex on the survey. Of these 2,444 who identified their sex, 1,849 (76%) indicated they were male and 595 (24%) indicated they were female.

Analyses: The analyses reported herein include only those alumni who indicated that they had completed both the Interdisciplinary Project and the Major Project.

For each of the 50 core survey items, frequencies for each response option were obtained and converted to percentages (number of responses/number of all responses for that item). In addition, for the 11 core items that asked alumni to indicate the extent to which various aspects of their time as undergraduates had affected them after they had completed their undergraduate

studies at WPI, percentages were collapsed across the response options of "Positively, Somewhat," "Positively, Moderately," and "Positively, Much." Also, for the 39 core items that asked alumni to indicate the extent to which their formal project experience at WPI had impacted their abilities, perceptions, understanding, or development regarding areas relevant to their professional lives, their world views, or their personal lives, percentages were collapsed across the response options of "Much" and "Very Much."

Also, for the 39 core items average responses were computed for perceptions of impact across all respondents and then for each of eight roughly equivalent graduation-year cohorts for the years 1974–2011. (The graduation-year cohorts on each end of the spectrum each contained four years while the six graduation-year cohorts between them each contained five years.) Averages were computed using the following scale: 0 = Not At All, 1 = A Little Bit, 2 = Moderately, 3 = Much, and 4 = Very Much.

To determine whether or not differences in perceived impact of project work between two groups were statistically significant, Mann-Whitney *U* tests were conducted. The Kruskal-Wallis one-way analysis of variance by ranks was used to determine whether or not the differences in perceived impact of project work across graduation-year cohorts were significant.

Results: Impact of Project Based Learning

Alumni were asked to rate the impact of 11 different aspects of undergraduate experience and responses indicated that almost all alumni believed that the Interdisciplinary Project and the Major Project had positive impacts. Collapsing responses across both projects revealed that 98% of respondents believed that either the Interdisciplinary Project or the Major Project had affected them positively either "somewhat," "moderately," or "much" after having completed their undergraduate studies.

Table 2 begins the exploration of the alumni responses for the 39 questions exploring different dimensions of project impact. Tables 2 through 6 display the percentages of alumni who indicated either "much" or "very much" impact of the project experiences. Each table presents items in descending order according to this percentage. The *n* presented in each row refers to the number of alumni who responded to that survey item, not to the number who responded "much" or "very much."

Tables 2 through 4 convey findings for survey items that are linked to the learning outcomes listed in the "Background" section of this report, and each of these tables identifies the outcome(s) to which the item is linked.

Table 2 conveys findings for survey items that focused on perceived impacts of professional relevance that were not primarily focused on interpersonal skills or communication ability. Approximately two thirds of respondents indicated that their project work at WPI had enhanced their abilities in areas key to professional success in engineering and the sciences: developing ideas; identifying, analyzing, and solving problems creatively through sustained critical investigation; and integrating information from multiple sources. Even more—over 70%—indicated that their project work had helped them to take responsibility for their own learning.

Table 2. Perceived Impact of Project-Based Learning on Professionally-Relevant Areas Related to Undergraduate Learning Outcomes			
Area of Impact	**Outcome**	***n***	**% "Much" or "Very Much"**
Take responsibility for own learning	10	2475	72
Develop ideas	10	2473	68
Solve problems	6	2471	67
Integrate information from multiple sources	7	2477	65
Master fundamental concepts and methods in the major	2	2466	61
Use current technology	3	2453	60
Develop a solid base of knowledge	1,2	2466	58
Make connections across disciplines	7	2461	52
Understand ethical responsibilities	9	2314	35

A finding of note in this table is that 35% of respondents indicated that their project work expanded their understanding of ethical responsibilities. While this is a somewhat small proportion, this is one of the most complex challenges faced by undergraduate engineering and science programs.

Findings for items targeting perceived impacts of professional relevance that were primarily focused on communication ability or interpersonal skills are conveyed in Table 3. For items that explored project impact on improvement of basic communication skills (e.g., writing, speaking, communicating visually, and delivering presentations), just under half to more than half of respondents indicated that they believed their project work had helped them either "much" or "very much." Perceived impact was even stronger for areas that focused more broadly on interpersonal skills (e.g., functioning on a team, managing projects, and interacting within a professional capacity) with about two thirds responding likewise. Additionally, just over half indicated that their project work had enhanced their ability to be an effective leader "much" or "very much."

Table 3. Perceived Impact of Project-Based Learning on Interpersonal and Communication Skills Related to Undergraduate Learning Outcomes			
Area of Impact	**Outcome**	***n***	**% "Much" or "Very Much"**
Function effectively on a team	5	2419	66
Effectively manage a project	5	2470	65
Interact effectively within a professional capacity	5	2463	64
Effectively manage interpersonal dynamics	5	2465	58
Write clearly and effectively	4	2490	56
Communicate effectively visually	4	2468	53
Be an effective leader	5	2418	53
Deliver effective presentations	4	2453	51
Speak clearly and effectively	4	2470	48

The WPI undergraduate program goal to lead students to form a deep appreciation of the interrelationships among basic knowledge, technological advance, and human need is intertwined with ULO 8, which states that graduates of WPI will be aware of how their decisions affect and are affected by other individuals separated by time, space, and culture. Table 4 conveys survey responses for survey items that were relevant to those issues of development of world view.

Findings showed that around 30% of alumni believed their project work helped them "much" or "very much" in the context-specific areas of understanding people of other racial and ethnic backgrounds, understanding people of other cultures, and respecting cultures outside of their own. Impact was similar or greater with regard to issues relevant to impact on world view that are not context-specific: expanding understanding of global issues, awareness of how decisions affect and are affected by others, and understanding of the connections between technology and society. Percentages responding "much" or "very much" to items targeting these broader issues were 31%, 41%, and 50%, respectively.

Table 5 conveys findings for survey items that are not directly linked to the ULOs, but that may be perceived as valuable and important, nonetheless. Of the 11 areas of what might be called "unintentional positive impact" conveyed in Table 5, four had more than 50% of respondents indicate "much" or "very much" impact.

Table 4. Perceived Impact of Project-Based Learning on World Views Related to Undergraduate Learning Outcomes			
Area of Impact	**Outcome**	***n***	**% "Much" or "Very Much"**
Understanding of the connections between technology and society	*Program Goal*	2456	50
Aware of how decisions affect and are affected by others	8	2422	41
Understand people of other cultures	8	1945	32
Understand global issues	8	2304	31
Understand people of other racial and ethnic backgrounds	8	1969	30
Respect for cultures outside of own	8	2026	29

Two areas of impact that clearly hold strong value are those that targeted the extent to which project work enhanced alumni ability to function effectively in the "real world" and the extent to which project work helped alumni develop a stronger personal character. And for both areas, high percentages of alumni—61% for real-world functioning and 66% for character development—indicated "much" or "very much" impact of project work.

Table 5. Perceived Impact of Project-Based Learning on Areas Beyond Undergraduate Learning Outcomes		
Area of Impact	***n***	**% "Much" or "Very Much"**
Develop a stronger personal character	2461	66
Function effectively in the "real world"	2460	61
View issues from several different perspectives	2460	55
Feelings that own ideas are valuable	2455	52
Enriching life in ways that were not necessarily academic or work-related	2384	45
Feelings of being able to "make a difference"	2444	40
Feeling connected to my university's community	2436	36
Achieve work/life balance	2381	30
Feeling connected to a community that is not related to my university	2335	23
Desire to maintain involvement with my university's community	2445	22
Desire to maintain involvement with a community that is not related to my university	2317	18

Like Table 5, Table 6 conveys findings for survey items that are not directly linked to the ULOs, but items in Table 6 are directly linked to professional advancement, which is perhaps an unarticulated desired outcome of all undergraduate programs. Responses indicated that while just over 20% of respondents believed their project work provided them with professionally beneficial connections, it provided approximately twice as many (38%) with knowledge or experience that helped them change their minds about future plans—something of particular value when considering the importance of career satisfaction. Even more notable, though, is that over half of respondents indicated that their project work enhanced their ability either "much" or "very much" to succeed in business or industry.

Table 6. Perceived Impact of Project-Based Learning on Professional Advancement, Beyond Undergraduate Learning Outcomes

Area of Impact	***n***	**% "Much" or "Very Much"**
Opportunities that students from other universities did not have	2459	63
Succeed in business or industry	2446	54
Knowledge or experience that helped to inform future plans	2438	38
Professionally beneficial connections	2436	22

Engineering Majors vs. Non-Engineering Majors: While this was not designed as a research study and no hypothesis testing had been planned, an informal review of survey results revealed that project work may have led to differences in perceived impacts for WPI alumni who had majored in engineering when compared to WPI alumni who had majored in non-engineering fields. Those potential differences were explored through comparative analyses, and the results follow.

Mann-Whitney *U* tests revealed that the distributions of responses from alumni who had majored in engineering were statistically significantly different than those of responses from alumni who had majored in a non-engineering field for 20 of the 24 areas of impact that the survey investigated and that are linked to the ULOs listed in the "Background" section of this report ($p \leq .025$ for all but one of the statistically significant comparisons; $p = .028$ for the remaining statistically significant comparison). While the Mann-Whitney *U* test compares the distributions of *all* of the data from two independent groups, for ease of interpretation by the reader, each of the tables that follows presents the percentages of alumni who responded either "much," or "very much."

For all but one of the 24 areas of comparison, a larger percentage of engineering majors rated project impact as having been "much" or "very much" positive when compared to non-engineering majors. (The difference for the one exception—extent to which project work contributed to mastery of fundamental concepts and methods in the major—was not statistically significant, though.) Items in each table are presented in order of descending magnitude of the difference between the groups with regard to the percentages who responded either "much" or

"very much," and all statistically significant differences are presented first, followed by non-statistically significant differences. When a difference between group distributions was statistically significant, the percentages for each group responding "much" or "very much" and the *p*-values are bolded. (Note that the *n*s provided in each cell refer to the number of individuals in the group to which the cell refers who were included in the analysis and not to the number who responded either "much" or "very much.")

Tables 7 through 9 convey comparative findings for survey items that are linked to the ULOs listed in the "Background" section of this report, and each of these tables identifies the ULO or ULOs to which each item is linked.

Table 7 conveys comparative findings for engineering and non-engineering majors for survey items that focused on perceived impacts of professional relevance that were not primarily focused on interpersonal skills or communication ability.

Table 7. Comparative Perceptions of Impact of Project-Based Learning on Professionally-Relevant Areas: Engineering vs. Non-Engineering Majors

Area of Impact	Outcome	% "Much" or "Very Much"		*p*
		Engineering	Non-Engineering	
Solve problems	6	**70** (*n* = 1770)	**60** (*n* = 701)	**<.001**
Develop ideas	10	**71** (*n* = 1776)	**62** (*n* = 697)	**<.001**
Make connections across disciplines	7	**54** (*n* = 1764)	**46** (*n* = 697)	**<.001**
Integrate information from multiple sources	7	**67** (*n* = 1776)	**60** (*n* = 701)	**.001**
Take responsibility for own learning	10	**74** (*n* = 1774)	**68** (*n* = 701)	**.001**
Use current technology	3	**61** (*n* = 1760)	**57** (*n* = 693)	**.005**
Understand ethical responsibilities	9	**36** (*n* = 1664)	**33** (*n* = 650)	**.022**
Develop a solid base of knowledge	1,2	59 (*n* = 1777)	55 (*n* = 689)	.178
Mastery of fundamental concepts and methods in the major	2	60 (*n* = 1776)	62 (*n* = 690)	.811

Table 8 conveys comparative findings for engineering and non-engineering majors for survey items that focused on perceived impacts of professional relevance that were primarily focused on interpersonal skills or communication ability.

Table 8. Comparative Perceptions of Impact of Project-Based Learning on Interpersonal and Communication Skills: Engineering vs. Non-Engineering Majors				
Area of Impact	**Outcome**	**% "Much" or "Very Much"**		***p***
		Engineering	**Non-Engineering**	
Function effectively on a team	5	**69** (*n* = 1740)	**58** (*n* = 679)	**<.001**
Effectively manage a project	5	**68** (*n* = 1768)	**57** (*n* = 702)	**<.001**
Effectively manage interpersonal dynamics	5	**61** (*n* = 1765)	**50** (*n* = 700)	**<.001**
Be an effective leader	5	**56** (*n* = 1745)	**46** (*n* = 673)	**<.001**
Deliver effective presentations	4	**53** (*n* = 1753)	**46** (*n* = 700)	**.001**
Speak clearly and effectively	4	**50** (*n* = 1767)	**44** (*n* = 703)	**.001**
Interact effectively within a professional capacity	5	**66** (*n* = 1758)	**61** (*n* = 705)	**.004**
Communicate effectively visually	4	**54** (*n* = 1767)	**49** (*n* = 701)	**<.001**
Write clearly and effectively	4	**57** (*n* = 1779)	**53** (*n* = 711)	**.015**

Table 9 conveys comparative findings for engineering and non-engineering majors for survey items that focused on perceived impacts on world views.

Table 9. Comparative Perceptions of Impact of Project-Based Learning on World Views: Engineering vs. Non-Engineering Majors				
Area of Impact	**Outcome**	**% "Much" or "Very Much"**		***p***
		Engineering	**Non-Engineering**	
Understanding of the connections between technology and society	*Program Goal*	**53** (*n* = 1766)	**43** (*n* = 690)	**<.001**
Aware of how decisions affect and are affected by others	8	**44** (*n* = 1741)	**35** (*n* = 681)	**<.001**
Understand global issues	8	**33** (*n* = 1662)	**26** (*n* = 642)	**<.001**
Respect for cultures outside of own	8	**30** (*n* = 1459)	**26** (*n* = 567)	**.028**
Understand people of other racial and ethnic backgrounds	8	31 (*n* = 1407)	27 (*n* = 562)	.083
Understand people of other cultures	8	33 (*n* = 1391)	31 (*n* = 554)	.073

Off-campus Project Experiences vs. On-campus Project Experiences: As was stated earlier, this study was not designed as a research study and no hypothesis testing had been planned. An

informal review of survey results, however, revealed that project work may have led to differences in perceived impacts for WPI alumni who had completed at least one project off campus when compared to WPI alumni who had not completed any project off campus. Those potential differences were explored through comparative analyses, and the results follow.

Mann-Whitney *U* tests revealed that the distributions of responses from alumni who had off-campus projects were statistically significantly different than those of responses from alumni who had on-campus projects for 19 of the 24 areas of impact that the survey investigated and that are linked to the ULOs listed in the "Background" section of this report ($p \leq .005$ for all but one of the statistically significant comparisons; $p = .006$ for the remaining statistically significant comparison). While the Mann-Whitney *U* test compares the distributions of *all* of the data from two independent groups, for ease of interpretation by the reader, each of the tables that follows presents the percentages of alumni who responded either "much" or "very much."

For all but one of the 19 statistically significant differences (extent to which project work contributed to mastery of fundamental concepts and methods in the major), a larger percentage of alumni with off-campus projects rated project impact as having been "much" or "very much," positive when compared to alumni with on-campus projects. Items in each table are presented in order of descending magnitude of the difference between the groups with regard to the percentages who responded either "much" or "very much," and all statistically significant differences are presented first, followed by non-statistically significant differences. When a difference between group distributions was statistically significant, the percentages for each group responding "much" or "very much" and the *p*-values are bolded. (Note that the *n*s provided in each cell refer to the number of individuals in the group to which the cell refers who were included in the analysis and not to the number who responded either "much" or "very much.")

Tables 10 through 12 convey comparative findings for survey items that are linked to the ULOs listed in the "Background" section of this report, and each of these tables identifies the ULO or ULOs to which each item is linked.

Table 10 conveys comparative findings for alumni who completed off- and on-campus projects for survey items that focused on perceived impacts of professional relevance that were not primarily focused on interpersonal skills or communication ability.

Table 10. Comparative Perceptions of Impact of Project-Based Learning on Professionally-Relevant Areas: Alumni with Off- vs. On-Campus Projects				
Area of Impact	**Outcome**	**% "Much" or "Very Much"**		***p***
		Off Campus	**On Campus**	
Understand ethical responsibilities	9	**43** (*n* = 1018)	**29** (*n* = 1296)	**<.001**
Make connections across disciplines	7	**57** (*n* = 1045)	**48** (*n* = 1416)	**<.001**
Integrate information from multiple sources	7	**68** (*n* = 1049)	**63** (*n* = 1428)	**.005**
Mastery of fundamental concepts and methods in the major	2	**58** (*n* = 1043)	**63** (*n* = 1423)	**.003**
Solve problems	6	70 (*n* = 1044)	66 (*n* = 1427)	.063
Take responsibility for own learning	10	73 (*n* = 1049)	71 (*n* = 1426)	.862
Use current technology	3	59 (*n* = 1043)	61 (*n* = 1410)	.685
Develop ideas	10	69 (*n* = 1045)	68 (*n* = 1428)	.154
Develop a solid base of knowledge	1,2	58 (*n* = 1042)	58 (*n* = 1424)	.347

Table 11 conveys comparative findings for alumni who completed off- and on-campus projects for survey items that focused on perceived impacts of professional relevance that were primarily focused on interpersonal skills or communication ability.

Table 12 conveys comparative findings for alumni who completed off- and on-campus projects for survey items that focused on perceived impacts on world views. The differences that are seen between alumni who completed off-campus projects and those who did not are striking for the context-specific areas of understanding people of other cultures, respecting cultures outside of their own, and understanding people of other racial and ethnic backgrounds. The percentages of those with off-campus projects who indicated that their project experience expanded either "much" or "very much" their understanding of people from other cultures and their respect for other cultures were 29 and 27 percentage points higher, respectively, when compared with the percentages of those with on-campus projects who responded the same. Regarding growth of understanding of people of other racial and ethnic backgrounds, the percentage of those with off-campus projects who indicated significant impact of their project experience was 18 percentage points higher when compared with the percentage of those with on-campus projects who indicated significant impact. In addition, there was a striking difference regarding the non-context-specific impact of expanding understanding of global issues: 20% more off-campus project alumni indicated that their project experience expanded their understanding of global

issues either “much” or “very much” when compared to the percentage of on-campus project alumni who responded likewise.

Table 11. Comparative Perceptions of Impact of Project-Based Learning on Interpersonal and Communication Skills: Alumni with Off- vs. On-Campus Projects

Area of Impact	Outcome	% “Much” or “Very Much”		*p*
		Off Campus	On Campus	
Deliver effective presentations	4	**62** (*n* = 1052)	**43** (*n* = 1401)	**<.001**
Speak clearly and effectively	4	**58** (*n* = 1053)	**41** (*n* = 1417)	**<.001**
Interact effectively within a professional capacity	5	**73** (*n* = 1053)	**58** (*n* = 1410)	**<.001**
Effectively manage interpersonal dynamics	5	**66** (*n* = 1052)	**52** (*n* = 1413)	**<.001**
Communicate effectively visually	4	**60** (*n* = 1050)	**47** (*n* = 1418)	**<.001**
Function effectively on a team	5	**73** (*n* = 1039)	**61** (*n* = 1380)	**<.001**
Be an effective leader	5	**59** (*n* = 1044)	**49** (*n* = 1374)	**<.001**
Effectively manage a project	5	**70** (*n* = 1050)	**61** (*n* = 1420)	**<.001**
Write clearly and effectively	4	**61** (*n* = 1054)	**52** (*n* = 1436)	**<.001**

Table 12. Comparative Perceptions of Impact of Project-Based Learning on World Views: Alumni with Off- vs. On-Campus Projects

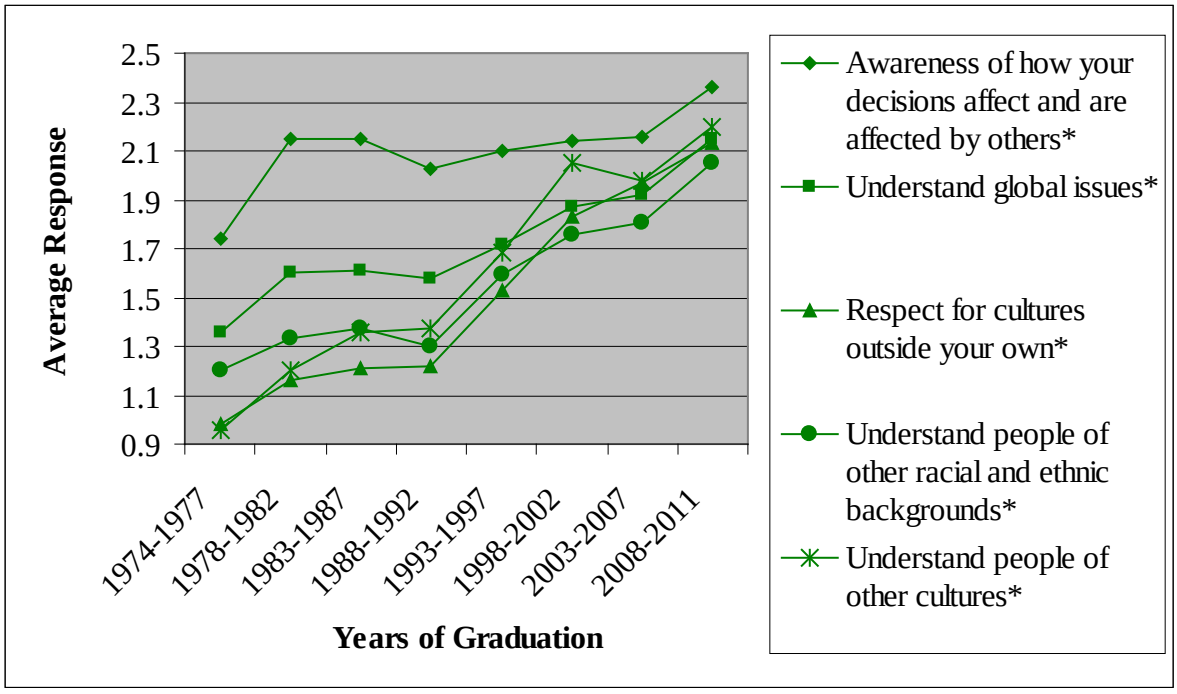
Area of Impact	Outcome	% “Much” or “Very Much”		*p*
		Off Campus	On Campus	
Understand people of other cultures	8	**47** (*n* = 948)	**18** (*n* = 997)	**<.001**
Respect for cultures outside of own	8	**43** (*n* = 960)	**16** (*n* = 1066)	**<.001**
Understand global issues	8	**42** (*n* = 1014)	**22** (*n* = 1290)	**<.001**
Understand people of other racial and ethnic backgrounds	8	**39** (*n* = 949)	**21** (*n* = 1020)	**<.001**
Aware of how decisions affect and are affected by others	8	**48** (*n* = 1042)	**36** (*n* = 1380)	**<.001**
Understanding of the connections between technology and society	*Program Goal*	**53** (*n* = 1039)	**48** (*n* = 1417)	**.006**

Changes and Stability over Time: While it is beyond the scope of this paper to conduct an in-depth examination of how perceptions of project impact differ depending of year of graduation of alumni (or passage of time, depending on perspective), some work has begun in that regard

and some is presented here. Following are two graphs depicting time trends across years in the study. Viewed together, they illustrate that over the almost-40-year duration of the program some perceived impacts have shown upward trends, some downward trends, and some stability.

The graphs report the *average responses* for perceptions of impact for each of eight roughly equivalent graduation-year cohorts. To interpret average ratings, the following scale applies: 0 = Not At All, 1 = A Little Bit 2 = Moderately, 3 = Much, and 4 = Very Much.

Presented in Figure 1 are trends across graduation cohorts in average ratings of perceptions of project impact on areas of world-view-relevant ULOs. This graph shows that while the means are low, the trend across graduation years for each item is strongly positive for all of these five areas of perceived impact, with statistically significant changes over time as measured by the Kruskal-Wallis test ($p < .001$ for each of the five trends; while the Kruskal-Wallis test does not rely on means for its computation, they are provided here for ease of interpretation for the reader). This is especially interesting given the comparatively lower percentages of alumni ratings of project impact related to world-view-relevant ULOs (see Table 4) and given the striking differences between ratings of impact of these same areas by alumni with off- and on-campus projects (see Table 12).



*Note: Kruskall-Wallis test was statistically significant at $p < .001$.

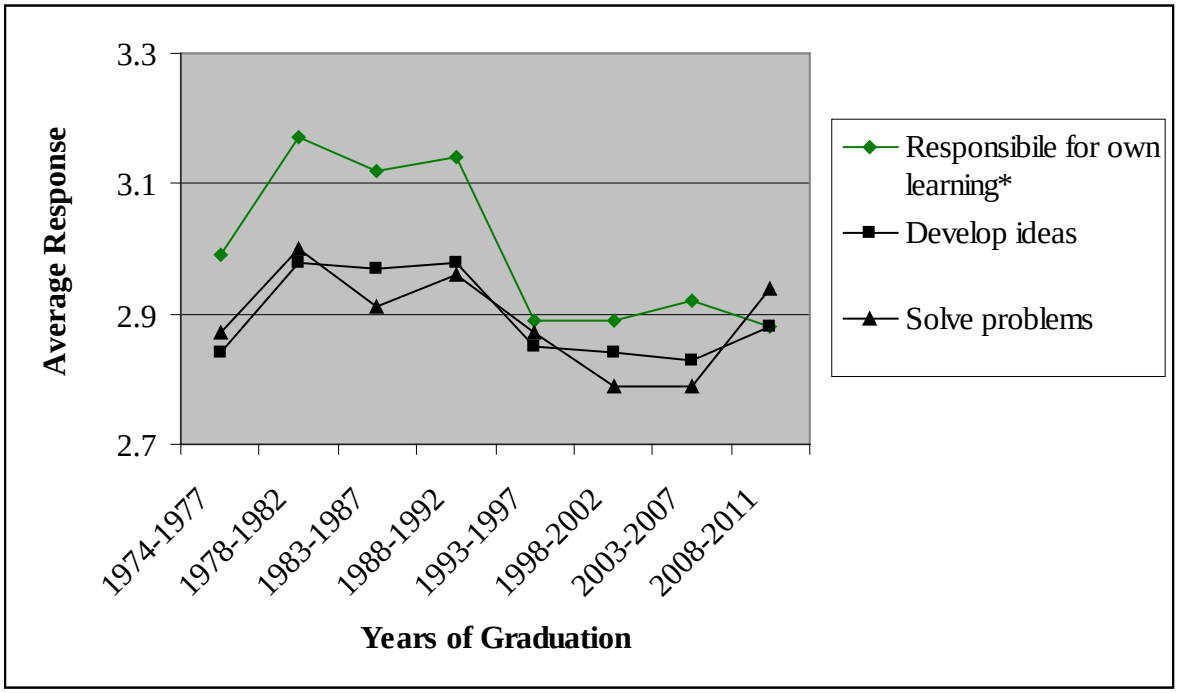
Figure 1: Time Trends for Areas of Impact Related to World-View-Relevant Undergraduate Learning Outcomes

For purposes of interpretation, it may be helpful for the reader to know that beginning in 1998 the off-campus component of project work became more intentional regarding recruitment and

selection of students and preparation of faculty advisors. In addition, more project centers in more locations, including new sites in the developing world, were opened.

In contrast to the low but increasing ratings seen in Figure 1, Figure 2 depicts trends across graduation cohorts for average means that are high but that either decrease over time or remain stable.

Of all areas of impact assessed through the survey, extent to which project work enhanced alumni ability to take responsibility for their own learning received the highest average rating across all respondents (M = 3.00). As seen in Figure 2, there also was a statistically significant decrease across average ratings across cohorts for this area of impact ($p < .001$). Contrast this with non-statistically significant ($p > .05$) time trends for average ratings for the two areas of impact that received the next highest average ratings across graduation cohorts—extent to which project work enhanced ability to develop ideas (M = 2.90) and extent to which project work enhanced ability to identify, analyze, and solve problems creatively through sustained critical investigation (M = 2.89)—and it can be seen that in some regards impact of project work across graduation cohorts and over time has remained consistent and consistently good.



*Note: Kruskall-Wallis test was statistically significant at $p < .001$.

Figure 2: Time Trends for Areas of Impact Relevant to Undergraduate Learning Outcomes That Had the Three Highest Average Ratings Across All Years of Graduation

Summary and Discussion

The results obtained from the survey indicate clear support for the claim that formal project work, both in the major and in the interdisciplinary domain, has lasting impacts. The alumni

who completed the projects as part of their undergraduate education believe strongly that the experience had deep and lasting impacts. Pascarella and Terenzini[19] have synthesized an extensive literature on how college affects students, but no work focused specifically on the long-term impact of project-based learning.

For questions related to integrating information from multiple sources, problem solving, developing ideas, and taking responsibility for learning, 65% to 72% of alumni reported "much" or "very much" positive impact from projects.

In areas of teamwork and communication, the percentages of alumni reporting positive impacts of project work ranged from about half to about two thirds.

There were a few areas where the impact of project work appeared less positive. For example, only about 35% had a positive response for how formal project work enhanced their understanding of ethical issues, and questions related to cultural awareness had percentages of alumni reporting positive project impact that hovered around 30%.

Engineering majors reported more positive impact than non-engineering majors for 23 out of 24 questions related to the institution's undergraduate learning outcomes, and distributions of responses were statistically significantly different between the two groups for 19 of those 24 questions. The difference was statistically significant for all questions related to leadership, teamwork, and communication skills (Table 8).

Alumni who completed at least one project at an off-campus project center had more positive responses on 21 out of 24 questions related to the undergraduate learning outcomes. For 18 of those 21 questions that revealed more positive impact on those with off-campus projects, the distributions of responses between the two groups were statistically significantly different. The differences are particularly striking (though perhaps not surprising) for questions related to cultural awareness, where the percentages of positive responses from off-campus project students were more than two and half times greater than the percentages of positive responses from on-campus project students (Table 12).

Off-campus projects usually involve intensive academic preparation by trained social scientists, have external sponsors who are engaged in the work and interested in the outcomes, are conducted in a fulltime immersion, and are usually advised by faculty who have undergone training and are focusing fulltime on project advising. Furthermore, both students and advisors apply competitively to participate. It is reasonable to expect that a great deal of the differences being seen between on-campus and off-campus project impact can be attributed to those factors, rather than simply to the location of the project.

The changes over time are more difficult to interpret with confidence. For example, an increasing trend (as seen in Figure 1) could reflect changes in the program over time *or* decay in the impact of the program with passing time. We expect that the positive trend for questions related to cultural awareness (Figure 1) is related to the increased availability of and emphasis on off-campus project opportunities, but this requires further study.

The fact that there was little or no change in the alumni responses over time for some questions may be an indication of stability or robustness for some of the key impacts of project based learning. There is no significant difference between alumni rating of the impact of the project experience on their ability to "solve problems through sustained critical investigation" between 1974 and 2011.

For all of the trend analysis, it is important to keep in mind that the "trend" could be explained by changes in the faculty or program as well as the alum's place in their career. When you ask a question related to skills needed for lifelong learning, someone further along in life will have a different perspective than a recent graduate. The next phase of this study, already under way, is a series of interviews designed to explore further the patterns seen in the survey responses. One focus area for the interviews will be an exploration of the reason why the off-campus experience had such a profound effect on world views.

Charles Vest[4], in his final chapter to *Educating the Engineer of 2020* said that

> *Making universities and engineering schools exciting, creative, adventurous, rigorous, demanding, and empowering milieus is more important than specifying curricula details.*

Perhaps the central message from this study of 40 years of science and engineering alumni is that significant project work, deep research in the major and interdisciplinary work forcing students to work at the intersection of science and engineering with human need, provides a creative adventure that has deep and long-lasting impact on students of science and engineering.

Bibliography

1. Scriven, M. (1991). *Evaluation thesaurus* (4th ed.). Newbury Park, CA: Sage.
2. Prados, J.W. (1997) The Editor's Page, *Journal of Engineering Education*, vol. 86, no. 2, 1997, pp. 69—70.
3. National Academy of Engineering (NAE) (2004). *The Engineer of 2020: Visions of Engineering in the New Century*, Washington, D.C.: The National Academies Press
4. National Academy of Engineering (NAE) (2005). *Educating the Engineer of 2020: Adapting Engineering Education to the New Century*, Washington, D.C.: The National Academies Press.
5. NAE Grand Challenges web site: http://www.engineeringchallenges.org. Accessed 1/5/2013.
6. Apelian, D. (2010). Empowering First Year Students by Immersion in a Grand Challenges Course: Sustainable Development for the 21st Century, *Journal of Metals*, Vol. 62, No. 4, pp. 8 and 74.
7. National Academy of Engineering (NAE) (2012). *Infusing Real World Experiences into Engineering Education*, Washington, D.C.: The National Academies Press.
8. Kilpatrick, W.H. (1921). Dangers and difficulties of the project method and how to overcome them: Introductory statement: Definition of terms. *Teachers College Record*, 22 (4), pp. 283—287.
9. Felder, R.M, Felder, G.N., Dietz, E.J. (1998). A Longitudinal Study of Engineering Student Performance and Retention. V. Comparisons with Traditionally-Taught Students, *Journal of Engineering Education*, vol. 87, no. 4, pp 469—380.

10. Felder, R.M. (1993). Reaching the Second Tier: Learning and Teaching Styles in College Science Education, *Journal of College Science Teaching*, 23(5), pp. 286—290.
11. Dixon, A.G., Clark, W.M., and DiBiasio, D, (2000). Project-based Spiral Curriculum for Introductory Courses in ChE: Part 2: Implementation. *Chemical Engineering Education*, Vol 34 (4), pp. 296—303.
12. Litzinger, T.A., Lattuca, L.R., Hadcraft, R.G., and Newstetter, W.C. (2011). Engineering Education and the Development of Expertise, *Journal of Engineering Education*, vol. 100, no. 1, pp. 123-150.
13. Tsang, E. (Ed.) (2007). *Projects that Matter: Concepts and Models for Service Learning in Engineering*. American Association of Higher Education series on service learning in the disciplines. Sterling, VA, Stylus Publishing.
14. Savery, J.R. (2006). Overview of Problem-based Learning: Definitions and Distinctions, International Journal of Problem-based Learning, 1 (1). Available on line at http://dx.doi.org/10.771/1541-5015.1002
15. Boud D. and Feletti, G. (1997). *The Challenge of Problem Based Learning* (2nd ed.). London, Logan Page.
16. Alexander, G.L., Divine, G.W., Couper, M.P., McClure, J.B., Stopponi, M.A., Fortman, K.K., Tolsma, D.D., Strecher, V.J., Cole Johnson, C. (2008). Effect of incentives and mailing features on online health program enrollment. *American Journal of Preventative Medicine, 34*(5), 382- 388.
17. Porter, S.R. (2004). Raising response rates: What works? *New Directions for Institutional Research: Special Issue: Overcoming Survey Research Problems, 121*, 5- 21.
18. Warriner, K., Goyder, J., Gjertsen, H., Hohner, P., & McSpurren, K. (1996). Charities, no; lotteries, no; cash, yes: Main effects and interactions in a Canadian incentives experiment. *Public Opinion Quarterly, 60*, 542- 562.
19. Pascarella, E.T., and P.T. Terenzini (1991). How College Affects Students: Findings and Insights from Twenty Years of Research, John Wiley & Sons, San Francisco, CA.

Appendix

This section includes the exact phrasing of survey items targeting project impact on professional skills, world views, and personal life. For each question, the response options were:

Not At All, A Little Bit, Moderately, Much, Very Much, Not Applicable

Indicate the extent to which your formal project experience at WPI (either through Project One, Project Two, or both) <u>enhanced your ability to</u>:

1. Write clearly and effectively
2. Speak clearly and effectively
3. Communicate effectively visually
4. Deliver effective presentations
5. Interact effectively within a professional capacity
6. Effectively manage interpersonal dynamics
7. Function effectively on a team
8. Effectively manage a project
9. Be an effective leader
10. View issues from several different perspectives
11. Understand people of other racial and ethnic backgrounds
12. Understand people of other cultures
13. Integrate information from multiple sources

14. Make connections across disciplines
15. Identify, analyze, and solve problems creatively through sustained critical investigation
16. Develop ideas
17. Use current technology
18. Succeed in business or industry
19. Function effectively in the "real world"
20. Achieve work/life balance
21. Take responsibility for own learning

Indicate the extent to which your WPI formal project experience (either through Project One, Project Two, or both) expanded your:

22. Understanding of the connections between technology and society
23. Understanding of global issues
24. Awareness of how your decisions affect and are affected by others
25. Respect for cultures outside of own
26. Understanding of ethical responsibilities

Indicate the extent to which your WPI formal project experience (either through Project One, Project Two, or both) contributed to:

27. Development of a solid base of knowledge
28. Mastery of fundamental concepts and methods in your major
29. Feelings of being connected to the WPI community
30. A desire to maintain involvement with the WPI community
31. Feelings of being connected to a non-WPI community
32. A desire to maintain involvement with a non-WPI community
33. Feelings that you could “make a difference”
34. Feelings that your own ideas are valuable

Indicate the extent to which your WPI formal project experience (either through Project One, Project Two, or both) contributed to helping you develop a stronger personal character. A strong personal character is characterized by things like taking pride in your work, operating according to a strong work ethic, persevering through adversity, being self-motivated, feeling self-confident, feeling self-aware, and operating according to a well-defined code of personal values.

Indicate the extent to which your WPI formal project experience (either through Project One, Project Two, or both) contributed to enriching your life in ways that were not necessarily academic or work-related. Life enrichment in this sense would include things like appreciating travel, enjoying new cultures, developing new personal interests (for example theater, food, or exercise), and developing and maintaining deep and lasting friendships.

Indicate the extent to which your formal project experience at WPI (either through Project One, Project Two, or both) provided you with:

37. Professionally beneficial connections
38. Opportunities that you believe students from other universities did not have
39. Knowledge or experience that helped you change your mind about your future plans