Scaffolded Project-Based Learning: First Year–Last Year

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Quick Overview

- Impacts of Project-Based Learning
  - Survey 40 years of WPI alumni
- WPI approach to PBL (Signature Work)
- Humanities & Arts for Science & Engineering
  - Critical part of the scaffold
- Impossible Problems for First-year students
  - You can (and should) start before the students are ready for project work.
Three Questions

• What do you do with projects now?

• Why do you use projects?

• What do students gain from projects?
A Little Bit about WPI

- ~4,000 undergrads
- ~2,000 grad students
- 97% Science and Engineering
- 150 years old
- Project-based for more than 40 years
Build from the Top Down:

**Signature Work**

- **Major Project:** \( \frac{1}{4} \text{ of the } 4^{th} \text{ year (MQP)} \)
  - Research or design in the major
- **Interactive Project:** \( \frac{1}{4} \text{ of the } 3^{rd} \text{ year (IQP)} \)
  - *Science & Eng* meets *Human Need*
- **Humanities & Arts:** \( \frac{1}{4} \text{ of the first two years} \)
  - Focus area + Inquiry Seminar/Practicum
- **Impossible Problems in the First Year: GPS**
WPI and AAC&U Signature Work

Graduation Requirements:

- HUA + Inquiry Seminar: 18 Credits
- Interactive Project: 9 Credits
- Major Project: 9 Credits
Objectives for Project-Based Learning

• Applying knowledge to complex problems in practical settings
• Understanding problems in social and cultural context
• Learning new topics quickly
• Communicating effectively in written, oral, and visual forms
• Interacting productively with teammates, faculty advisors, sponsors, communities
What Constitutes Project Work?

- Authentic, open-ended problems
- Real, messy, interdisciplinary
- Goal, methods, criteria chosen by students
- Requires integration, analysis, synthesis
- Generation and communication of useful results
Long-Term Impacts of Project-Based Learning

• Research questions:
  – *What are the long-term impacts of the IQP and MQP?*
  – *Do IQPs and MQPs prepare WPI alumni for success?*
  – *How do different groups experience the IQP and MQP?*

• Areas of Impact:
  – *Professional impacts, Personal impacts, World views*

• Subjects: 20,000+ alumni, 1974-2011

• Stratified sample: 10,072 alumni surveyed

• 25% response (n=2532)
  – 95% confidence level, ± 1.8% confidence interval
<table>
<thead>
<tr>
<th>Professional Impacts</th>
<th>% Positive Responses</th>
</tr>
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<tbody>
<tr>
<td>Responsibility for own learning</td>
<td>89</td>
</tr>
<tr>
<td>Develop ideas</td>
<td>89</td>
</tr>
<tr>
<td>Solve problems</td>
<td>88</td>
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<td>Effective professional interactions</td>
<td>87</td>
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<td>Function effectively on a team</td>
<td>86</td>
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<tr>
<td>Effectively manage a project</td>
<td>86</td>
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<tr>
<td>Write clearly and effectively</td>
<td>83</td>
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<tr>
<td>Succeed in business or industry</td>
<td>78</td>
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<tr>
<td>Be an effective leader</td>
<td>78</td>
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<tr>
<td>Speak clearly and effectively</td>
<td>76</td>
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Alumni Voices: Preparation for Work

“[Project work] is really a problem-solving and project management education, and that’s something I use constantly at work.”

“The [project work], it’s close ... to what I do now. ... I can’t think of another school that would have been suitable for me to be doing what I do now ... life is projects.”

“I think the [projects] just really mimic, at a very early age—a formative age ... in your learning process— ... how to work, how to be successful.”
## Personal Impacts

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<tr>
<th>Impact</th>
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<tr>
<td>Stronger personal character</td>
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<tr>
<td>Feeling own ideas are important</td>
<td>79</td>
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<td>Feeling able to make a difference</td>
<td>66</td>
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<td>Enriched personal life</td>
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“...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”
Alumni Voices: Personal Impacts

“[The projects]... give you the opportunity to become independent, work on your own, find ... solutions...it just gave me the opportunity to develop my character and drive.”

“To have something that really takes you out of your comfort zone ... where you can’t predict exactly what’s going to happen. ... helped me to become a stronger person as I headed out of college.”

“The projects gave me an enhanced confidence level, that I could achieve—and it sounds almost cocky—but I could achieve almost anything.”
Other Findings and Recurring Themes

• “Real world” aspect highly motivational
  – Authentic problems provide richness, complexity
  – Stakeholders provide motivation, context

• Adversity in projects viewed as an asset in hindsight

• Unpredictability of projects promoted learning, growth, and confidence

• Projects viewed as a “safe environment” to develop professional skills
Building from the Top Down: Signature Work

- **Major Project:** \( \frac{1}{4} \) of the 4th year (MQP)
  - Research or design in the major
- **Interdisciplinary Project:** \( \frac{1}{4} \) of the 3rd year (IQP)
  - General education requirement, involves all faculty
- **Humanities & Arts Requirement:** \( \frac{1}{4} \) of the first two years
  - Focus area + Inquiry Seminar/Practicum
- **Impossible Problems in the First Year** (Great Problems Seminars)
Major Project (MQP)

- Senior year, 9 credit, in major
- Not a course
- Teams of 1-4 w/ Faculty advisor
- Professional-level challenge, e.g., design or research
- Many sponsored by corporations, research labs (often for fee)
Examples of Major Projects

- Water supply modeling for Wachusett Reservoir
  - MA Dept of Conservation & Recreation
- Cam blade load design
  - Gillette
- Sustainable landscape architecture
  - Stantec, Canada
- Human artery plaque progression
  - National Science Foundation
Interdisciplinary Project (IQP)

- Junior year, 9 CH, gen ed requirement
- *Not a course* – students conduct inquiry under faculty direction
- Teams of 3-4 from all fields
- Faculty from all fields
- Problem at society/technology interface
- Most sponsored by NGOs, gov’t, nonprofits
Examples of Interdisciplinary Projects

• Improving Community Nutrition
  ─ AIDS Project Worcester

• Erosion and flood control in informal settlements
  ─ Namibia Housing Action Group

• Alerting systems and egress for the deaf
  ─ VicDeaf, Melbourne, Australia

• Promoting Sustainable Transportation
  ─ Facilities Department, WPI
Educational Objectives of IQP and MQP

- Research skills
- Problem solving
- Critical thinking
- Communication
- Teamwork & leadership
- Ethical awareness
- Contextual understanding of science & technology
WPI Global Projects Program

- 65% of students complete at least one project off campus

- WPI operates 40 off-campus Project Centers around the globe

- Mix of international, domestic, and local programs

- Typical cohort: 24 students (6 teams of 4) and 2 faculty advisors

- Alumni completing a project off campus reported greater gains in 33 of 39 areas
Support and Scaffolding

- Nonacademic preparation
  - Mandatory orientations, policies
  - Health, safety, sexual assault
- On-site advisor training
  - Managing risk, dealing with crises
  - Handling teamwork & personal problems
  - Building relationships with sponsors
  - Representing WPI locally
- Range of support offices
  - Interdisciplinary and Global Studies
  - Gordon Library
  - Student Development & Counseling
  - Office of Student Life
  - Accounting, financial aid, etc.
Pause ... Breathe ...

Enter the Humanities and Arts
2nd Year: Humanities and Arts

- 5 courses – depth in one area
- Capstone project options

Inquiry Seminar
Practicum
Language Immersion
Choose a Focus Area

• Areas for Depth (four courses in one area):
  o English, History, Philosophy, Writing, Literature,
  o Drama, Music, Art,
  o Modern Languages

• After taking all five humanities courses, students complete a humanities project in their chosen depth as a part of a capstone course titled an inquiry seminar or practicum.
Examples of Humanities Projects

- Projects are chosen by the students (with the help of the advisors). Some recent projects include:
  - The philosophical exploration of freedom/freewill and its applicability to robots/robotics (depth: Philosophy)
  - An animated short film (depth: Digital Art)
  - An exploration of the origins and characteristics of Chinese Cyber Nationalism (depth: History)
  - A Jazz saxophone performance of styles from swing to fusion (depth: Music)
  - Our Theatre Program produces a number of plays every year in which drama students complete their projects in a variety of ways (acting, production, design, lighting, etc.)
Pause ... Breathe ...

*Move to the First Year*
Projects in the First Year

• Provide context and motivation for subsequent course and project work
• Leverage the students’ expectations that college will be different
• Increase intellectual engagement
• Increase community engagement
• Build confidence!
• Earlier access to internships and relevant jobs
• Acknowledge their knowledge – they already know quite a bit!
Great Problems Seminars

• Focus is on one global problem
  – Energy, food, water, health care, climate change

• Co-Instructors from different disciplines
  – Technical/Humanist pairings

• Learning outcomes stress skill development rather than content knowledge

• This structure allows multi-faceted look at the problem
  – Economic, policy, technical, cultural
Course Structure

• First Half
  – Many perspectives
  – Many assignments – individual and group
  – Lots of presentations and writing

• Second Half
  – Students divide into teams (3-5)
  – Select/Receive project topic – a small piece of the big problem
  – Research the problem, identify potential solutions, evaluate them, select one, develop an assessment plan
  – Produce a report/poster
  – Present to campus community
Outcomes

• Intrinsic motivation of participating student increased; non-participating students decreased (Wabash)
• Student engagement much higher (Wabash)
• Students report gains in oral, written communication, problem solving, research, teamwork, cultural awareness, understanding values
• Increased willingness to take leadership roles (external evaluation)
• Increases in number of HUA courses taken
Students say…

• Despite what we learned about water ..., we learned something more important; that even three college freshmen ...can design something that can make change."

• "The main thing that we will take from this project is the knowledge that the great problems of our time are not possible to solve with one simple solution. It takes different perspectives to see all the issues that could arise, and it takes various approaches to cover all the bases.”

• “The group skills and time management skills acquired are irreplaceable.”

• “...your class has helped me contribute to discussions.”

• “I just wanted to thank you both for a fantastic GPS class and to let you know that it helped me get a really great job for the summer!”
Pause … Breathe …

Wrap it up
Aside: Signature Work Changes the Culture

- **Student learning and culture**
  - enhanced general education and major-specific outcomes
  - global competency
  - purpose beyond requirements

- **Faculty culture**
  - lower barriers
  - broad involvement
  - pride in “signature program”

- **Community partners**
  - sustainable relationships
  - mutual benefits
Changing Faculty and Student Roles

- **Faculty move away from**
  - Dispensing information
  - Authority and expert

  and toward
  - Guiding inquiry
  - Coach and explorer

- **Students move away from**
  - Listening/watching
  - Dependence
  - *Gaining* knowledge

  and toward
  - Creating/discovering
  - Independence
  - *Making* knowledge
Projects Torque the Curriculum

- Student expectations let you demand more in every class, starting in the first term.
  
  on the first day

- This requires a different kind of support:
  - Library, Writing Center, Counseling Center, +++

- Authentic Program Assessment:
  
  If students are not ready for the Major Project:
  “they will rub our noses in it.”
Institute on Project-Based Learning at WPI

• Inaugural offering: June 25-27, 2015
• Co-sponsored by WPI and AAC&U
• Workshop topics
  — PBL as a first-year and general-education strategy
  — Partnering with external organizations for PBL
  — Team formation, development, and mentoring
  — Integrating PBL into STEM courses
  — Feedback, evaluation, and assessment strategies for PBL
  — PBL in major capstones
• Applications now being accepted at wpi.edu/+2015Institute
Thanks!

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On-Campus Project Scheduling

1 Term = 7 weeks
1 Semester = 2 Terms

3 Courses/Term
6 Courses/Semester

A Term
Signal Analysis
Psychology
IQP

B Term
Human-Computer
IC Design
IQP

C Term
Probability
RF Circuits
IQP

D Term
Networks
Materials
VLSI Design

Key Point:
Signature work never competes with more than two regular courses!