The Foundation Coalition
....an agent of change

First-Year Engineering at the University of Massachusetts Dartmouth

http://www.foundationcoalition.org

Student Quotes

"I loved working in groups. I was really good at calculus, one of the guys was really good at chemistry and we would end up teaching each other."

"Hands-on is the best way for me to learn."

"It [living with other engineering students] was definitely good because they [other students] were always right there…We always had study groups, and we actually had the dorm people get us a huge table with all these lights and we asked if they could put a huge white board on the wall. We could use it to teach each other, which we still use every day." - Foundation Coalition Student at UMD

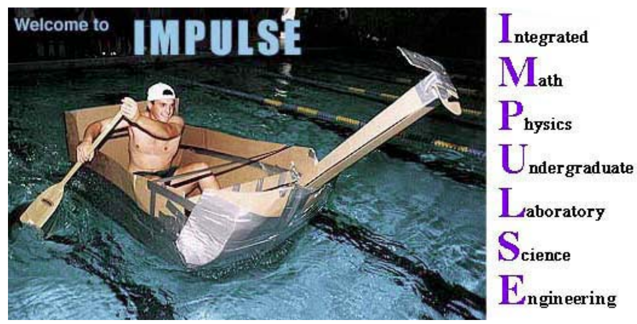
Introduction

The development of a new integrated first-year engineering program at the University of Massachusetts Dartmouth began with a review of the educational literature. It indicated that we should be able to improve first-year education while also reducing instructional time. The literature is consistent, and often overwhelming, in the following conclusions [1, 2, 3, 4, 5, 6,7,8]:

- Active and collaborative learning techniques can result in higher performance and longer information retention compared to traditional methods.
- Integrating math, science and engineering courses is an effective means of teaching students to deal successfully with cross-disciplinary problems.
- Integrating English into engineering, science and math courses is an effective way to improve the performance of engineering students in oral and written communication.
- Integrated first-year programs improve retention rates, especially of women and minorities.

In addition, there is evidence that studio classes using hands-on, collaborative learning could cost less than the traditional lecture-recitation-laboratory classes [1].

IMPULSE - Our Freshman Year Experience



The UMD IMPULSE faculty team built on the results of several previous successful undergraduate experiments at other universities such as those at RPI [1] and in the NSF Foundation Coalition [2]. The new program, called IMPULSE (**I**ntegrated **M**ath, **P**hysics and **U**ndergraduate **L**aboratory **S**cience, and **E**ngineering) [3,7,8]:

- integrated multiple subjects
- taught and required teamwork among students and faculty
- used active and cooperative learning
- encouraged formation of a learning community of students and faculty
- included rigorous assessment to evaluate and improve performance.

Many courses in IMPULSE were developed to exploit a technology intensive classroom to improve learning.

250 entering Freshman → Calculus ready

1st Semester	2nd Semester	3rd Semester
Calc I	Calc II	Calc III
Engr I	Engr II	Depends on Major
Phys I	Phys II	
English I	English II	
Other	Other	

250 entering Freshman → Pre-Calculus Algebra & trig

1st Semester	2nd Semester	3rd Semester
Pre Calc	Calc I	Calc II
Engr 0	Engr I	Engr II
English I	Phys I	Phys II
Chem I	English II	Major
Other	Other	Other

Legend: Integrated | Linked | Independent | Optional

Designing for Long-term Effectiveness

It is common for educational innovations to die when particular people are no longer involved. This is a real concern. The IMPULSE curriculum was designed to include features that would make it robust and would encourage its extension into more of the engineering and science curricula. Specifically we designed the curriculum to:

1. **Lower the cost of delivery.** This is a powerful incentive for college Deans to keep the program going and to enlarge it. The new hands-on studio sections of 48 students have a lower cost of delivery than traditional courses at UMD. This is easy to understand for English courses with a typical section size of 25; however, studio classes are also less expensive to deliver than the traditional lecture hall, recitation and laboratory class combination typically used in the sciences. When there are 96 students taking a total of 31 credits of IMPULSE courses with each class taught by an instructor and a TA, the university can save an estimated $124,000 per year.

2. **Build in thorough, accurate assessment.** This is critical to the lasting success of the curriculum because it drives future improvements and provides insight for good decisions. Assessment data about the overall performance of courses is the only effective counter to misinformed judgments based on a few students' poor performance in later classes. Performance data showed significant improvements, which encouraged faculty to adopt the new methodology. Assessment in IMPULSE courses is both formative and summative. Control groups were established using a cluster method on baseline pre-test scores, high school rank, and SAT scores. Comparisons were made between IMPULSE students and the control groups on the Force Concepts Inventory Test and the Mechanics Baseline Test as well as common exam questions and student and faculty surveys.

3. **Build on faculty teamwork.** Faculty members function as a team in IMPULSE. This provides long-term stability in the curriculum because the methodology is rooted in the team, not in a single member. In order to maintain this stability, however, the number of new teachers in the program each year must be kept small and allowance has to be made for training new members.

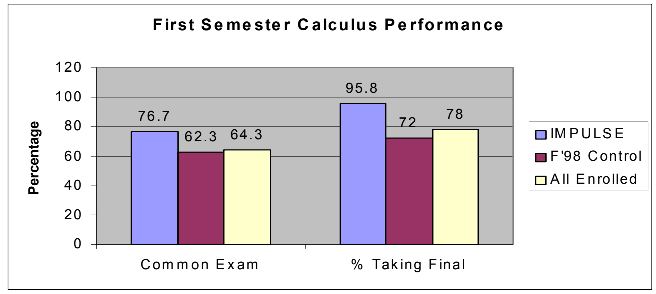
4. **Pilot full size sections.** Full-size pilot courses cause instructors to develop and tune their teaching methods at the outset for the appropriate number of students. In addition, assessment data provides direct insight into the performance that would be seen when the pilot courses move into the required program. We used a pilot size of 48 students because it was the section size ultimately desired in the freshmen program at UMD.

5. **Have a scale-up plan.** For a lower division curriculum to become mainstream, it must deal with all of the special cases that arise because of transfer students, AP credit and students who leave school but return after various lengths of time. In order to have at least one reasonable solution, a plausible plan was sketched that would include all students in some version of IMPULSE during scale-up. This was done informally before starting the pilot to make sure that the basic plan was not fatally flawed.

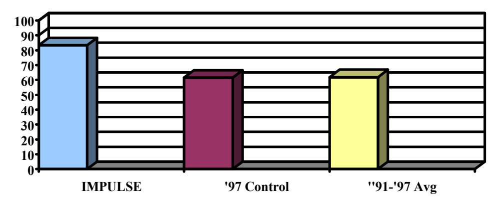
University of Massachusetts Dartmouth

Does IMPULSE Work?

Considerable assessment and evaluation has already been done on the IMPULSE program but measurements are being made on a continuing basis using a variety of measurement devices. Our assessment results so far appear to be similar to those found in other integrated programs that have involved more students over several years. While our assessment data so far is very positive about the performance improvement produced by the IMPULSE program, it also indicates that opportunity exists for further improvement.



Experience at other universities has indicated that our scores will likely improve as our instructors become more adept with active learning methods. Early antidotal information points to improved retention and overall performance. With assessment providing insight into performance, a process of continuous improvement is starting to develop in the IMPULSE program that should move the program toward even better results.



Retention After 3 Semesters

References for Further Information:

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2. Frair, K., Cordes, D., Evens, D., and Froyd, J., "The Foundation Coalition – Looking Toward the Future," *Proceedings of the Frontiers in Education Conference*, Pittsburgh, PA, November 1997.
3. Kowalczyk, R. and Hausknecht, A., "Using Technology in an Integrated Curriculum – Project IMPULSE," Proceedings of the 11th Annual International Conference on Technology in Collegiate Mathematics, Addison-Wesley Publishing Co., 1999.
4. Drake, Susan M., *Planning Integrated Curriculum: The Call to Adventure*, Alexandria, VA: Association for Supervision and Curriculum Development, 1993.
5. Miller, Kathleen A., *Curriculum: To Integrate or Not to Integrate,* Viewpoints, 1995.
6. Al-Holou, N. et. al., "First-Year Integrated Curricula Across Engineering Education Coalitions", *Journal of Engineering Education*, vol. 88, no. 4, October 1999.
7. Pendergrass, N. A., Laoulache, Raymond N., Dowd, John P., and Kowalczyk, Robert E., "Efficient Development and Implementation Of An Integrated First Year Engineering Curriculum," *Proceedings of the Frontiers in Education Conference*, Tempe AZ, November 1998.
8. Pendergrass, N. A., Laoulache, Raymond N, Kowalczyk, Robert E., Dowd, John P.,, "Efficient Development and Implementation of an Integrated First Year Engineering Curriculum," to appear in the *Proceedings of the ASEE Conference*, Albuquerque, New Mexico, June 2001.

Whether you're just getting started or looking for some additional ideas, the Foundation Coalition would like to help you improve integration across your engineering classes through workshops, web sites, lesson plans, and reading materials. For suggestions on where to start, see our web site at: http://www.foundationcoalition.org or contact: Jeffrey Froyd at froyd@ee.tamu.edu or 979-845-7574.