SCUE
STUDENT COMMITTEE on UNDERGRADUATE EDUCATION

Student Committee on Undergraduate Education
Proposal for Problem-Solving Learning at Penn

December 2007

I. Motivation for Problem-solving Learning at Penn

Penn's historic and current mission calls for the marriage of theory and practice. President Amy Gutmann proclaims in the Penn Compact that Benjamin Franklin's "pragmatic vision for higher education is no less essential today than it was in 1749." As students, we now attempt to address the strategic problem that President Gutmann has proposed: "What should Penn specifically do in the 21st century to effectively implement the 'pragmatic vision for higher education' that had inspired Franklin's 18th century proposal for a college in Philadelphia" (Harkavy 2006)?

Supposing one of the goals of the Penn undergraduate experience is to educate students to improve the world, the most effective way to align the university around this goal is to orient components of the undergraduate experience towards problem solving. Educational and psychological research plus Penn student and faculty experiences demonstrate that confronting highly complex problems leads to the highest levels of cognitive development and student learning (Appendix A-1).

While the Penn education currently offers some problem-solving opportunities to undergraduates, the offerings are far less than ideal. Across the university, in 2004-5, there were 2,118 undergraduates involved in 46 academically-based community service (ABCS) courses representing Penn's community partnerships in West Philadelphia (Netter Center 2007). We, however, view ABCS as just one manifestation of problem-solving learning. Besides ABCS, senior thesis and studio courses, Wharton Management 100, Engineering senior design projects, and Nursing clinicals, **the available options at Penn do not represent the ideal problem-solving learning experience.** Though Ideas in Action courses more closely resemble that ideal, the range of opportunities fails to meet potential university demand. We intend to demonstrate that the problem-solving learning framework is applicable across the undergraduate experience.

We believe problem solving can be Penn's comparative advantage. Despite many years of conversations, no group has put forward a comprehensive plan for implementing that vision across a wide range of fields. As the Student Committee on Undergraduate Education, we find it appropriate to attempt this here.

The most effective strategy to cultivate problem-solving learning through courses and other academic programs across the undergraduate education is to establish student-faculty collaborative research groups, each focused on solving a particular problem. We propose a concrete, replicable model of student and faculty collaborative groups to effectively integrate courses, research, and extra-curricular activities in order to best align resources towards solving a particular problem.

These collaborative research experiences are *ends* in themselves. These student-faculty groups would be well-positioned as effective units of problem solving and knowledge production across the university. These experiences enable students to contribute to an academic discipline and to improve the conditions of world beyond that discipline through their research.

These collaborations of individuals seriously invested in a specific problem are the most organic and democratic way, thus the best *means*, to develop new courses and extra-curricular programming structured around solving particular problems. Penn faculty and administrators have affirmed that such courses enhance student learning of the subject matter, sparking interest that can later be pursued (Appendix A-2).

II. Evidence

We recognize four outstanding collaborative groups of students and faculty at different levels of development working to solve problems of particular interest to society today. We recommend that these four serve as models to the Penn community of how students and faculty can engage in collaborative research to solve problems and to develop courses and extra-curricular programs focused on solving those problems. (See Appendix B for more information and contacts)

Sustainable Energy

Faculty and students have begun to form a collaborative research group to solve the problem of sustainable energy in the 21st century. Faculty from Chemistry and Environmental Studies in SAS and Materials Science in SEAS have united to form the Energy Research Group (ERG) investigating topics including fuel cells, solar power, and hydrogen storage and involving over 40 affiliated faculty members. Students from chemistry, environmental studies, and student groups have concurrently established the Penn Hub for Environmental and Energy Teamwork (PHEET). The critical problem of sustainable energy brings about integration of knowledge across disciplines. Only through this collaborative structure can research programs and courses be developed. This group would contribute to carrying out the university Presidents Climate Commitment, which President Gutmann signed in February 2007.

The group's primary vision is to best utilize Penn resources to contribute to the development of sustainable energy integrating the cutting-edge science with policy making. This group intends to attract undergraduates by officially establishing itself through a lecture series during the spring of 2008. The undergraduate leaders have already attended weekly faculty seminars. Discussions regarding regular student-faculty lunch seminars and a conference are underway. These students and faculty envision a class in which undergraduate chemists, policy makers, entrepreneurs, and environmentalists collaborate to address this issue. To further Penn's contribution, the ERG and PHEET have discussed an integrated scholars program, similar to the Vagelos Program, alongside an interdisciplinary research center, placing undergraduates at the cutting edge of the nation's most critical sustainability and energy research.

Social Entrepreneurship

A coalition of student groups including the Wharton Dean's Undergraduate Advisory Board is working towards developing new ways to integrate social entrepreneurship into the Wharton undergraduate curriculum. There are no programs in this field at any other *undergraduate* business school. At the same time, students have brought together Wharton faculty researching this topic to discuss the future of social entrepreneurship at Wharton. Currently, the Wharton undergraduate curriculum does not have any academic program specifically focused on teaching students the unique skills necessary to explore their interests in the field of social entrepreneurship. One component of the Wharton Dean's Advisory Board's recommendations is to form a secondary concentration to begin to fill this void.

This student collaboration also hopes to expand students' co-curricular options for exploring social entrepreneurship. This would represent a large collaborative group of Penn undergraduates and faculty working together solving local and global problems through business. In the short term, these groups have begun to sponsor a range of events from guest speakers to town hall meetings. Currently, the Dean's Advisory Board is running a survey to measure student demand for future programming. In the long term, this student-faculty coalition will be able to develop a new research center that will be dedicated to social entrepreneurship and will support a number of "Social Enterprise Scholars" who will engage in a four-year track of solving problems in this field.

Recognizing this student-faculty Social Entrepreneurship group as the nucleus of Penn's institutional effort to solve global problems through business knowledge will align Penn's intellectual resources – students and faculty – in the most effective manner.

Nutrition

Undergraduates interested in Health and Nutrition and participants in the Netter Center's Penn Programs for Public Service helped establish a group of faculty to solve the problem of inadequate health, especially nutrition in urban areas. Led by Frank Johnston, faculty members from the School of Arts and Sciences, School of Nursing, Schools of Medicine, and Dental School sharing this intellectual interest met in July 2007.

This student and faculty group could link existing centers such as the Agatston Urban Nutrition Initiative (UNI), which has been running community fitness nights, fruit stands, and education throughout West Philadelphia since 1992, and the research in Nursing and Medicine. Students and faculty have identified a need to form new problem-solving courses and to develop an interconnected progression through coursework, community involvement, research, and group projects. Fortunately, the new Nutrition Minor, is a starting point for developing a four-year track of nutrition problem solving. Additionally, there is already an Ideas in Action course and there is a collection of ABCS courses that confront this larger problem of improving nutrition. As SCUE, we envision a framework to unite these courses with the extracurricular activities, to promote the collaborative development of new programs. In the short term, students have met to begin to plan a seminar series for spring 2008 that would effectively launch this student-faculty group, a concrete opportunity for new students to get involved in working together to solve the problem of poor nutrition.

Sustainable Development

Now in its fourth year, the Penn chapter of Engineers Without Borders USA (PennEWB) works to improve the quality of life through sustainable solutions in local and global communities. On the international front, PennEWB brings together students, faculty, NGOs and communities that have a particular need for various types of development. From research to corporate sponsorship, all components of the project are student driven. Two trips to Terreritos, Honduras have taken place (May 2006 and 2007) to construct a water pipeline and pit latrines to improve clean water access and sanitation. The group will travel to Cameroon to provide clean water to a medical facility in December 2007. The participating faculty mentor conducts an eight-week one-credit course to educate the student team about the approaches it will take to solve the particular problem identified in the community selected. The students then receive another credit for participating in the trip. On the local front the group volunteers at Saul Agricultural High School in North Philadelphia presenting on sustainable development topics in a classroom once a week. They supplement these with after-school activities related to sustainable technologies.

Recently, PennEWB has expressed interest in creating opportunities to further study sustainable development at Penn through developing courses and a minor in sustainable development. The group has also sponsored events highlighting Social Entrepreneurship and Sustainable Energy demonstrating the interconnectedness among the models we illustrate in this document. Coordination of these models according to this proposal would provide PennEWB with a more interdisciplinary group of students for their project teams, committees, and classes. Such collaboration could also be a venue for other funding and creative course development involving professors from other problem-solving clusters.

III. University-wide Recommendations

We recommend that the Provost's or President's Office extend financial and rhetorical support to these models and establish an initiative to support and promote emerging groups solving other problems. The premise for this university support is the ideal that these problem-solving learning groups are the undergraduate manifestation of the Penn Compact, particularly its tenets on Engaging Locally and Globally and Integrating Knowledge (Appendix C).

Funding would support the following three components of these groups:

1) To fund Professors for research with undergraduates and coordination of these groups. Precedent for this kind of funding includes the 2007 Research Mentorship initiative through the Provost's Office and CURF. The appointments of the five eminent PIK scholars reflect a dedication to integrating knowledge, and as SCUE, we recommend that this commitment be extended to reward Penn professors for leading these interdisciplinary problem-solving groups.

2) To provide course development grants. Where appropriate, this initiative should involve the Netter Center, since it already supports yearly ABCS course development grants. The Center for Teaching and Learning could also provide assistance to these professors through the structure of faculty-faculty dialogs, which the CTL conducts. Undergraduate research assistants could be hired for course development affirming Penn's value placed on student participation. It is common for current undergraduate teaching assistants to assume such roles.

3) To secure funding for the logistics of running interdisciplinary lectures, seminars and symposia focused on bringing together undergraduates and faculty from a range of departments around particular complex problems of interest.

Additionally, we recommend that the incoming Director of CURF assume the role of coordinating these groups. This individual would be a liaison connecting students, faculty, and administrators. He or she would serve as the hub of information for research affiliated with these groups, situating CURF at the center of these innovative and exciting undergraduate research opportunities.

We recommend that central administration encourage the curricula four undergraduate schools to represent the value of problem-solving learning courses and provide ample opportunity for undergraduates to engage in this kind of learning without creating an additional requirement. We identify a goal, for instance, in the College, that each Major and each General Requirement should count at least one problem-solving learning course a year. As SCUE, we would, however, caution against setting the re-labeling of existing courses (namely ABCS courses) as the *sole* curricular goal. We consider this to be a necessary part of the solution, but not a sufficient condition of larger cultural change.

We stress that the initiative must come from those invested in the academic material and the specific problem at hand. It is critical that these student-faculty clusters maintain their "bottom-up" nature, yet be supported by "top-down" coordination and incentives to facilitate their growth.

We recognize that the change we, as the Student Committee on Undergraduate Education, have outlined above calls for a substantial shift for some students and faculty. To be at the cutting edge of *both* knowledge creation and teaching methods, however, the university must *support* these efforts. In its doctrine, the Campaign for Penn cites a "pragmatic love for knowledge" as a core Penn value. We believe that these historic and current institutional values manifest themselves in making the development of the next generation of problem solvers to be one of the highest goals of the Penn undergraduate education. These groups embody natural intellectual community, substantial undergraduate research, and innovative teaching and learning. In recognition of all of this, our goal is to put problem-solving learning on the minds and agendas of students, faculty, and administrators as we all look forward to "making history" in the coming years at Penn.

Appendix A: Evidence for the benefits of problem-solving learning

We break this evidence into two sections: first, the educational and psychological research and two, the theoretical and moral arguments that support this claim.

A-1. The reader may be interested in evidence supporting the claim: problem-solving learning benefits undergraduates. Below is some evidence from psychological and educational perspectives.

Problem-solving learning in the classroom is not an educational trend, rather the teaching method that strongly reflects the proven ways that undergraduates best learn and develop cognitively. With a commitment to problem-solving learning, Penn will be able to contribute to the higher education community with this pedagogical experiment.

Penn cognitive psychologist Dr. Christine Massey is a learning specialist at the Institute for Research in Cognitive Science. In the *Almanac*, she sorts through the buzz words, which faculty members are accustomed to hearing, as she addresses the question, "How does one discriminate the fads and fancies from the recommendations that would warrant serious investments of time and effort?" (Massey 2006). Dr. Massey "makes the case for making a systematic effort to include in a Penn education opportunities for a particular strategy that [she] characterize[s] here as complex, open-ended, problem-solving learning (PSL)". From the work of John Dewey to more recent advances, research converges to a model for the progression of students' epistemological orientations from absolutist, through multiplist, and ultimately to relativist perspectives.

> Faced with a complex, open-ended problem to solve, the learner may be forced to ask questions such as "What am I trying to figure out or do? What do I already know? How well do I know it? What *don't* I know?" Instead of engaging in generic strategies or study skills, the student is prompted to think at a meta-strategic level: "How am I going to frame this problem? What are the essential constraints? What might a solution look like? What strategies might work? How will I know if they are working?"
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> When undergraduates start to recognize and grapple with the complexity and uncertainty of knowledge, some of the most important work of a college education can begin in earnest. The focus of learning shifts toward such matters as theory and argument, critical consideration of ideas from multiple perspectives, development of standards of evidence, logical reasoning, and the ability to take systems of thought as objects of study and to compare them rather than only being able to operate within a given one…
>
> Learning to think within a discipline and using complex problem-solving learning are complementary components in an undergraduate education. Each component makes the other more purposeful and effective. (Massey 2006)

Unfortunately, not all students leave Penn having experienced this relativist orientation towards knowledge, which is crucial to problem solving, most notably academic research. A range of literature discuss exactly these issues. In addition, many ABCS courses have records of student reflections documenting the personal development of Penn students throughout their problem-solving learning experiences.

Former Harvard President Derek Bok confronts the largest problems of undergraduate education and focuses on critical thinking and problem solving as fundamental skills undergraduates should develop. He takes a critical view of faculty writing,

> While pockets of innovation exist throughout American higher education, most professors teach as they traditionally have, confident that the way that have worked well enough in the past will continue to serve in the future. Though trained in research themselves, they continue to ignore the accumulating body of experimental work suggesting that forms of teaching that engage students actively in the learning process do significantly better than conventional methods in achieving goals, such as critical thinking and problem-solving, that faculties everywhere hold dear.
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> … Since faculty members normally keep abreast of published work in their fields, the content of their courses tends to be reasonably up to date. The same cannot be said of their teaching methods. (Bok 2006)

Some critiques of this vision point out that "critical thinking," is a "decidedly instrumental [goal of the undergraduate education] that conceives of students as problem-solvers-in-training to be deployed into a society that needs them" (Delbanco 2007).

When citing the most formative experiences in their undergraduate careers, Penn alumni claim they learned their problem-solving skills "as a result of extra-curricular activities at Penn" (Berger 2006). They recommend efforts to focus on "helping Penn students more fully develop their abilities to solve real world problems collaboratively" (Berger 2006). We are comfortable with stating that components of the undergraduate experience should center on critical thinking and problem solving in order to equip students to solve the most challenging problems in the world.

It is crucial to note that some Penn faculty members have begun to talk regularly about problem-solving learning and have made some innovative strides in their classes. For instance, a number of engineering professors are experimenting with problem-solving learning in the classroom. Spotlighted in the *Gazette*, Professor Joel Weingarten explains, "Traditional engineering education sort of just treats students like filing cabinets. It fills them up with lots of data, they spit it back out on tests, and they do that on 20 or 30 disjoined core courses" (Popp 2007). Engineering students, who often pride themselves on a problem-solving degree, admit to experiencing a sequence of, as Dean of the College Dennis DeTurck often puts it, "problem solved" learning experiences. Professor Dan Koditschek adds, "If you confront people early on with challenging laboratory environments, where it's clear that there's no right answer—*that we don't know what the right answer is*—I think it sets the whole framework for four years of inquiry-based education, critical thinking, lifelong learning skills, and collaborative interdisciplinary work." Undergraduate Dean of Engineering Sampath Kannan says that this teaching style requires that "no one is watering down core concepts." That is, "It's an attempt to get students hooked, but without really sacrificing anything in the end." These engineering professors recently taught a pilot freshman course to demonstrate the benefits of these teaching methods for student learning. The same course was taught to multiple sections of freshmen, but only one section was taught predominantly problem-solving learning teaching methods. Beyond improved class performance, the pilot section "generated a recruiting conduit that has brought undergraduate manpower into [the professors'] research enterprises" (Popp 2007). These are the educational experiments that should be occurring all around the university building up the support for the claim that problem-solving learning truly benefits undergraduates.

Other faculty practicing problem-solving learning teaching methods have also begun to advocate for spreading this throughout the university. In particular, Professor of Anthropology, Frank Johnston wrote an article titled, "Reshaping Undergraduate Education at Penn: The Role of Problem-Solving Learning in the Curriculum." We agree with his claim, "The focus on real-world problems that characterizes problem-solving learning brings students into direct contact with communities in ways that increasingly incorporate democratic values into the educational process"

(Johnston 2005). To implement this reshaping he also has come to the conclusion of creating problem-solving clusters, for instance, around the social sciences. He recommends establishment of a problem-solving learning course development fund. We hope that such alignment of goals should only reinforce our voice as students.

A-2. The reader may be interested in evidence supporting the claim: Penn specifically should dedicate significant resources to solving the problems of the world by educating its students to solve them. Below is some evidence from philosophical, moral, and educational perspectives from the voices of current and former Penn faculty and administrators.

We begin with former Penn President Sheldon Hackney's claim, "The university's primary contribution to the betterment of the human condition comes through education and the creation of new knowledge" (Hackney 1986).

This commitment stems from Ben Franklin's proposal for the "good Education of youth". Still, President Gutmann, in her 2004 "Inaugural Address," proclaims that Franklin's "pragmatic vision for higher education is no less essential today than it was in 1749" (Gutmann 2004).

According to Dr. Lee Benson, Franklin understood that "knowledge should not be pursued for private gain." Rather, he believed in a university that strictly taught students the perfect intersection between theory and practice, in which students could apply what they learned to both real-world projects and the betterment of society. In particular, "Effective integration of ends and means, it cannot be overemphasized, was perhaps the basic general proposition on which Franklin's educational theory rested" (Benson 2005).

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Appendix B: Additional information on models

We list the contact people and organizations that are and should be affiliated with these four groups. We hope these lists are effective in pointing out the leaders of these initiatives, but we acknowledge that they may not be completely comprehensive.

Sustainable Energy

Faculty	Andrew Rappe
	John Fischer
Student Groups	Penn Hub for Environmental and Energy Teamwork (PHEET)
	Penn Energy Group (PEG)
	Undergraduate Assembly (UA)
Other	Environmental Sustainability Advisory Committee

Social Entrepreneurship

Faculty	Martin Asher
	Ian C. MacMillan
	Keith Weigelt
	Thomas W. Dunfee
	Nien-he Hsieh
Student Groups	Wharton Deans Advisory Board (WAB)
	EduHealth
	Management 100
	Social Impact Consulting
	Net Impact

Nutrition

Faculty	Charlene Compher
	Stella Volpe
	Frank Johnston
	Fran Barg
Student Groups	Penn Programs for Public Service Interns
	Nutrition Minor students
Other	Nutrition Minor
	Agatston Urban Nutrition Initiative (Netter Center)

Sustainable Development

Faculty	Kenneth Foster
	John Keenan
	Joseph Sun
	Tony Sauder
	Megan Doherty
Student Groups	PennEWB
	Penn International Business Volunteers (PIBV)
	Penn Society for International Development (SID)
Other	Weiss Tech House

Appendix C: How does problem-solving learning connect to the Penn Compact?

Engaging Locally and Globally

For some of these problem solving groups, West Philadelphia serves a natural laboratory. Still, the focus of some groups may be particular to communities abroad. In either case, the problem-solving learning we envision places a shared emphasis on student development and improving the world. We believe problem-solving skills are the best tools with which Penn can equip its students to achieve both of these ends.

On October 2, 2007, in her reception of the over $10 million donation establishing the Netter Center for Community Partnerships, she anticipates that the Netter gift "will greatly enhance Penn's ability to make a difference in our West Philadelphia community while creating new knowledge than benefit communities everywhere" (*Almanac* 2 Oct. 2007, Vol. 54, No. 6).

Integrating Knowledge

"The most challenging questions and problems of our time cannot be addressed by one discipline or profession. To comprehend our complex world, we must better integrate knowledge from different disciplines and professional perspectives in our research and teaching."
(Penn Compact Website 2007)

We support President Gutmann's value of integrating knowledge, and we conclude that it is the obligation of the University to create opportunities for students to integrate knowledge to solve real-world problems.

In recently, President Gutmann has especially focused on this integration of knowledge. On November 28, 2007 she presented her position paper, "Scaling Up," to the *United Nations Global Colloquium of University Presidents*, in which she professed:

> The intellectual challenge, therefore, is for universities to be more integrated, rather than segregated, in the way we do our academic work, both our research and teaching, so as to better address the real problems that need to be resolved to achieve global sustainability. Intellectual scaling up will call for greater integration and collaborations... As essentially educational institutions, universities have an especially important responsibility (and indeed incentive in keeping with our enlightened interest) to "walk the walk," as well as "talk the talk," in order to demonstrate to our societies and the world the social importance—and benefits—of integrating knowledge and putting such knowledge into use for the betterment of humankind.

We could not agree more with President Gutmann's rhetoric. We would argue that just as we must integrate knowledge to solve the problems to achieve global sustainability, so too we must collaborate to solve the other present and future problems of the world. **Hence we pose the challenge to the Penn community to "walk the walk" of "integrating knowledge and putting such knowledge into use for the betterment of humankind."**

What is one of Penn's largest efforts to achieve this end? The funding of Penn Integrates Knowledge professors, according to the Penn Compact website, is one of the prime examples of Penn's commitment to integrating knowledge. It reads, "Beginning with the recruitment of eminent scholars who will hold joint appointments in two schools and departments, Penn will achieve a truly successful partnership between arts and sciences and our professional schools that will benefit our students, our society, and our world."

We view this SCUE proposal as a move forward building on the "beginning" that President Gutmann has already established. We therefore claim that the funding for the student-faculty

groups problem-solving groups and the programs they develop fits into the Penn Compact's tenet of Integrating Knowledge. An alternative source would be to develop a new fund, Penn Problem-solving Learning Initiative. We applaud the appointments of five Penn Integrates Knowledge professors, and we would recommend that the same office reward professors for leading these collaborative problem-solving groups of faculty and students. Such funding would also distinguish these groups from Graduate Groups, Joint Degree Programs and University Minors. In particular, these problem-solving groups integrate knowledge from more than two disciplines to synthesize courses and programs solely structured around on solving particular interdisciplinary problems. Undergraduates inherently have much more interdisciplinary experiences leading us to believe that undergraduates are the gel that should be bringing resources from around the university together to solve the highly complex problems of the world.