

STAKEHOLDER EXPECTATIONS OF LEARNING IN FIRST-YEAR PROJECT-BASED COURSES

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Abstract

In the design of a curriculum, each course should have a well-understood role and relationship to the other courses, and clearly defined, student-centered objectives, stated in terms of learning outcomes for knowledge, skills and attitudinal outcomes [1]. The Report of the Task Force on Undergraduate Educational Commons [2] at MIT, which made recommendations to revamp the common educational experiences of our students, recommended an optional first year project-based course. Currently, planning and pilots are being conducted of such a course. The authors conducted a survey to determine the degree of community consensus on the desired learning outcomes for a first year project-based experience.

Project-based learning is built on an authentic issue or problem for which a solution is sought. Faculty identify problems that encompass the relevant concepts and principles, and then they design authentic tasks in which the thinking required is consistent with the thinking in a real world engineering setting. The task and setting reflect the complexity of engineering environments and encourage students to test their ideas against alternative views and contexts. The solution to the problem may include design-implement experiences. Projects provide opportunities for reflection on both the content learned and the learning process. While it is common to use project-based learning activities integrated within an existing discipline-based curriculum framework, some universities organize their entire curriculum around project-based experiences.

In order to better understand the community view of the role of project-based learning in the first year, we chose to survey the principal stakeholders of such an offering, i.e. those students and faculty who have a significant stake in its outcome. Voluntary interviews were conducted with representatives of four faculty stakeholder groups: leaders of academic enterprises; leaders of undergraduate programs; those directly teaching similar courses; and members of the Task Force on Undergraduate Commons, Committee on Undergraduate Programs, and Committee on Curricula. The Task Force was an ad hoc group that met for two years, and delivered a report outlining a new vision for the shared experiences of MIT students. The other two standing committees deal with the policy and curricular oversight of the undergraduate education. In addition current seniors, newly arrived freshmen, and high school seniors interested in MIT were interviewed.

Our objective was to collect information from stakeholders regarding their expectations of and thoughts about the first-year project-based courses and goals presented by the Task Force. This report summarizes the interview findings regarding perceived benefits, detriments and other concerns. In addition, in the domain of skills, we asked respondents to complete a survey instrument designed to determine expected learning outcomes of a project-based course for freshmen.

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This report will first give a brief background on early (first and second year) project-based courses at MIT and at other universities. With this context, the outcomes of the stakeholder survey will be presented, along with commentary and educational basis for the views, and implications for future curricular design summarized.

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Background of Project-based Courses at MIT

Project-based courses at MIT have a long history. Until the 1960s, the MIT engineering education was of course rich with design and project courses, as these formed an important organizing practice-based element of the education. With the introduction of engineering science as the organizing principle of engineering education in the 1950s, these early design oriented courses tended to diminish in number and perceived importance. In the 1960s the Institute created the laboratory requirement, which was originally intended to be available to students early in their studies, and have a project nature.

Over the past 20 years, early project-based experiences have been steadily reintroduced. They appear as optional freshman introductory courses, as part of alternative freshman year programs, and as integral parts of departmental second year programs. For example, the courses 12.000 Solving Complex Problems (also known as Mission X) and 16.00 Introduction to Aerospace Design have been engaging first-year students in optional freshman introductory courses available to all freshman. Terrascope, a learning community for first-year students, offers both Mission X and another project-based course 1.1016 Communicating Complex Environmental Issues: Designing and Building Interactive Museum Exhibits to freshmen in a small, supportive setting. Increasingly, second year core courses in engineering departments employ project-based learning. Recently 1.101 and 1.102 Introduction to Civil and Environmental Engineering Design I and II and the redesign of the EECS core including courses 6.01 and 6.02 Introduction to EECS I, II have brought project-based experiences to the sophomore year for students in these courses. For ten years, the Aeronautics and Astronautics Department's Unified Engineering (16.001-16.004) has incorporated an aircraft design-build exercise. Design and Manufacturing I (2.007) in Mechanical Engineering and its legendary design contest has been offered to sophomores for more than 30 years.

In an earlier major revision of the undergraduate commons, MIT created the Institute Laboratory Requirement. This requirement has its origins in another ad hoc committee, the 1965 Zacharias Committee report, written at a pivotal time between the transition from practice-based to engineering science-based models of engineering education. The Institute Laboratory Requirement, if enforced with its original intent, would require every MIT student to undertake a "work of project type" "at an early stage of his or her educational experience at MIT." The

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[groundwork for early project-based experiences is therefore already laid at MIT, both in regulation, and the in the rich array of contemporary offerings.](#) [3]

Project-based courses [at other Universities](#)

Of course, project-based and problem-based learning and courses are not unique to MIT. [In fact it is a subject of widespread development at universities throughout the world.](#) A well-known example is Aalborg University in Denmark. [Since 1974 their focus has been inter-disciplinarity and their pedagogy is centered on problem-oriented group work, emphasizing the links among industry, external organizations, and research.](#)

Problem-based learning is also in widespread use at Linköping University in Sweden. [More generic problem-based learning is similar to project-based learning, but does not necessarily include a hands-on or design-build component.](#) This method differs from the traditional method of learning by rote, and its purpose is to encourage students to become more actively involved in the problem-solving process. Most of the work takes place in groups that consist of 6-7 students.

Many universities in the United States also use project or problem-based pedagogies. For instance, the College of Engineering and Applied Science at the University of Colorado at Boulder in the late 1990s inaugurated the Integrated Teaching and Learning (ITL) Laboratory, a 34,500 sq. ft. interdisciplinary learning environment intended to foster hands-on, team-oriented learning. The ITL's curriculum-driven design accommodates a variety of learning styles and features two first-year design studios, an active-learning arena, a computer simulation laboratory, a computer network integrating all the experimental equipment throughout two large, open laboratory plazas, capstone design studios, group work areas and student shops. A pedagogical cornerstone of the ITL Program is First-Year Engineering Projects, a course specifically designed to allow beginning engineering students to experience the design-build-test cycle that characterizes engineering design. [4]

Olin College in Needham, Massachusetts bases its undergraduate engineering curriculum on an interdisciplinary, project-based approach emphasizing entrepreneurship, liberal arts, and rigorous science and engineering fundamentals. An open-ended hands-on project is part of every term at Olin, a key description of their curriculum is "At Olin, learning and doing go together from the start." [5]

These are only a small sampling of the more obvious examples of early project-based learning efforts around MIT, the United States, and international community. Clearly there is a rich set of examples from which to learn. We will now review the contemporary stakeholder views on first year project-based courses.

Overview of Stakeholder Expectation Study

The specific objective in carrying out the current study was to inform policy-level administration and faculty, as well as those developing specific courses, of general stakeholder opinions of project-based courses and the learning outcome expectations of project-based courses.

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In July 2006, over 100 faculty and administrators from all of MIT's schools were invited by email to participate in a personal interview designed to gather information on general stakeholder opinions of project-based courses and the learning outcome expectations of project-based courses. Forty-two voluntary interviews were conducted between July and October 2006 by Dr. Diane Soderholm, instructional designer, and/or Christopher Hansman, a summer staff member.

The respondents included representatives of four faculty stakeholder groups: leaders of academic enterprises – thirteen department heads and deans; leaders of undergraduate programs – sixteen undergraduate officers or heads of undergraduate programs; those directly teaching similar courses – twelve faculty of current first-year core courses or larger lead-in departmental core courses; and nine members of the Task Force on Undergraduate Commons, and Committee on Undergraduate Programs, and Committee on Curricula (summing to more than the 42 faculty interviewed due to multiple roles). While this sample represents only about 5% of the MIT faculty, it includes about 20-50% of those in these defined stakeholder groups. In addition, 58 students were interviewed: twenty current seniors for retrospective views; and new students for prospective views - twenty incoming freshmen, and eighteen high school seniors garnered at the admissions tour.

The interview had two parts for each of the faculty and student groups. The faculty participants were asked five general qualitative questions to elicit opinions and attitudes on first year project-based courses. Then they were asked to more quantitatively define the proficiency that would be expected at the end of a first year project-based course in certain skill domains. The results of these two approaches will be discussed sequentially below.

The five questions designed to elicit opinions and attitudes to project-based courses included:

1. Assuming project-based courses are implemented, what learning outcomes would you like to see students leave the course with?
2. Assuming the above objectives were met, how would you utilize them in your course/program/UROP?
3. What do you think the benefits or detriments of project-based courses for freshmen will be?
4. Would you like to be involved in a project-based course in the coming year?
5. Any other comments, questions, or concerns regarding project-based courses?

This report includes the results of questions 1, 3, and 5. Not enough of those interviewed responded to questions 2 and 4, either for lack of time or interest, to warrant analysis. The responses to questions 3 and 5 are discussed below under the headings of Benefits, Detriments and Other Issues. The answers to question 1 are included in the section regarding the expected proficiency survey. The students were asked slightly different questions, as will be discussed below.

Early versions of the results were shared with the instructors who were teaching pilot project-based courses for the Spring 2007 semester to assist them in further designing and developing their courses and accompanying learning outcomes.

Faculty Opinion Responses: Benefits of Project-based Courses for Freshmen

The objectives of a first year project-based experience, within the larger framework of problem based learning, are often summarized around four topics. Project-based learning can:

- Attract, excite and motivate students
- Provide a rich opportunity for students to learn important professional and life skills
- Introduce the students to the context of professional domain of practice
- Lay a pedagogic foundation for deep learning of fundamentals [6].

These themes are reflected in the discussion contained in the Task Force Report. Each of these topics will be developed further below, with appropriate extracts from faculty comments. After the discussion of the faculty inputs, which often reflect on the particular context of MIT, a commentary by the authors is provided which links the faculty reflections to the broader base of experience with project-based learning.

Attract, Excite and Motivate

First year project-based courses can *attract, excite and motivate students*, and provide intellectual variety and an opportunity to explore. They involve students “in exciting subject matter as quickly as possible” and help “solve the delayed gratification problem” of doing primarily papers and problem sets until the third year [extracted comments by faculty respondents are shown in quotes]. Such projects will “allow students to maintain the enthusiasm they enter MIT with.” Successful experiences can build student confidence that will “spill over into other learning” and help to overcome the sense of being “overwhelmed or beaten down” by the freshman year. Faculty commented that such courses “allow students to do what they came to MIT to do,” and help build a “community that helps in the transition from high school.”

As commentary, we would observe that universities world wide have found that project-based learning increases student motivation and improves students’ ability to apply engineering knowledge and skills to real-world problems. [7] Students arrive at university motivated by their understanding of the professional aspect of their major – scientists discover, engineers design and build and solve socially relevant problems, etc. Delaying authentic experiences until later in the education, and emphasizing theory and abstractions early in the education can discourage students, and dissuade them from engineering. Providing early project-based experiences to students tends to encourage, excite and motivate them. This is borne out in data, which indicates higher retention of students in engineering programs who participate in early project-based courses [8]. However it should be emphasized that while project-based learning does excite and motivate students, this *is not* the principal educational rationale for including such experiences early in the curriculum. We feel these lie in benefits such as skills, professional context and preparation for effective learning of the fundamentals, to be discussed next.

Important Professional and Life Skills

An important role of project-based courses is to develop *important professional and life skills*, often called *transferable or generic skills*, including synthesis and design, collaboration, communications, etc. [9]. Particular emphasis was placed by the faculty on those skills associated with self-directed learning and the value of perseverance – “trying things that don’t work and understanding why they didn’t work.” “Creativity within the bounds that are realistic”

and “learning that there is not only one answer” were also important outcomes. Attitudinal outcomes are also important – “Project-based courses are a creative opportunity, and can build self confidence.” Of the more specific skills that could be learned in a project-based setting, the most commonly cited were teamwork, communication and design. The further discussion of the opinions expressed on skills are discussed below along with the quantitative expectations on student proficiency.

The authors would observe that there are a wide variety of skills we expect our students to learn while at the university, and which our alumni consistently tell us are among the most valuable benefits of their education [10]. Among these are various modes of thought, including inquiry and discovery of knowledge, critical and creative thinking, a systems perspective, and problem solving. Attitudinal learning is also a key and long lasting benefit of education, teaching students the importance of ethical behavior, perseverance, and willingness to take appropriate risks. Interpersonal skills, including teamwork, communications and leadership are important life skills honed over the years at university. It is clear that many of these skills are far more easily taught in the context of a project than in the traditional setting of a lecture-recitation experience.

Context of Professional Practice

Project-based courses can introduce students to the *context of the professional domain of practice*, motivating the acquisition of and giving context to disciplinary knowledge. Faculty members observed that courses such as these “give students the opportunity to be collaborative and deeply interdisciplinary” simulating the collective and broad, rather than disciplinary approach taken to resolving problems in professional practice. Students in project-based courses will be exposed to more realistic tasks, and therefore learn to “deal with ambiguous complex problems,” “applying intelligence and analytic skills” to such problems. Such courses also “contribute to a student’s professional identity.”

As commentary, we would observe that project-based learning is important in setting the professional context for both future research and future applied practitioners. Project-based learning has also been found to support an education that instills in students an understanding of the consideration of use, an important attribute for successful researchers. [11] It facilitates interdisciplinary cooperation and interaction. By basing the model problems and projects involving simple engineering design and systems, links could also be made to some topics in first year math, physics, chemistry and biology, demonstrating the importance and relevance of these topics, and the degree to which the sciences are the basis of modern engineering. By linking the model problems and projects to a macro problem, it would be possible to make links to the humanities, arts and social sciences. Thus introductory project-based courses would play an important integrative role, now absent, in the education of first year students. [12][13]

Focusing on the context of future professional practice as an engineer, The CDIO Initiative (Conceive-Design-Implement-Operate) has identified project-based design-implement experiences as one of its twelve standards of best practices. [7]. The term *design-implement experience* denotes a range of engineering activities central to the process of developing new products and systems. Students develop product, process, and system building skills, as well as the ability to apply engineering science, in design-implement experiences integrated into the

curriculum. Design-implement experiences are structured and sequenced to promote early success in engineering practice. Iteration of design-implement experiences and increasing levels of design complexity reinforce students' understanding of the product, process, and system development process. [7]

Pedagogic Foundation for Further Learning of the Fundamentals

More subtly, project-based courses can play a critical role in laying a *pedagogic foundation for further learning of the fundamentals*. This is far more than just motivation. "If properly designed, students will be involved in authentic experiences." They will learn to "connect theory, principles and equations to something that works." Such concrete learning can have an important role in learning retention – "It is incredibly powerful to learn in an interesting context. It can be a lasting experience when learning hands on and students have a vested interest in the outcome." Such learning experience can cater to the variety of learning styles among our students – "a 'C' student in a lecture course can be an 'A' student in one of these courses." Some observed that secondary education now uses a great deal of problem-based learning, and therefore this is a "Mode of learning that freshmen are comfortable with, so it makes for an easier transition from high school for them."

As an observation by the authors, this important pedagogic benefit is not commonly understood, nor as well developed in the Task Force report. Kolb [14] has argued that there are various learning styles, which map onto four phases of the learning cycle: concrete experiences; reflective observation; abstract generalization; and active experimentation (and then back to concrete experiences in a loop). Our traditional lecture-problem set format best maps to the last two stages. But evidence suggests that many of our students, who learn from the concrete to the abstract, would be better served by an early concrete experience.[15] This would give them the personal cognitive structure onto which the abstractions they learn in many of our other theory-based courses could be mapped. The result is deeper learning of the abstractions, and better long-term retention. Project-based experiences provide a solid foundation upon which to build deeper conceptual understanding of disciplinary skills. [7]

Faculty Opinion Responses: Detriments and Other Issues of Project-based Courses for Freshmen

In response to the question, "What are the detriments of a project-based course in the freshman year?" faculty comments centered on pedagogical impact, curricular tensions, quality and resources.

Picking up again on the theme of *pedagogic impact*, there is a concern that freshmen are not prepared for project-based experiences – "Freshman don't know much, don't know all the principles yet, would these courses go better if a year was waited?" Others reflect the learning style match as a concern, "students, especially foreign students, would not find these courses a good experience – not good for all people, personalities, and learning styles." Some expressed a view that supports a portfolio of learning styles - "It is possible that not everyone has an aptitude for this type of thing, but it can't be that bad to learn it for one semester." The authors would support this last point, noting that the vast majority of courses our freshmen and sophomores

currently take are taught in one learning style (abstract to concrete), and having an option for one in another style would be a benefit for at least those students who learn in alternative styles, and perhaps all of our students.

Many faculty expressed concerns over *curricular tensions*. The most critical is simply the scarcity of time- “If take this, can’t take something else.” Project-courses “should not replace a GIR (General Institute Requirement)- should not be at the expense of a fundamental course.” There is also a concern about student learning demands – “Perhaps these are not as efficient as problem sets.” As an author reflection, most respondents believe that fundamentals should be taught in the first year, but fundamentals can include skills and attitudes as well. Faculty stakeholders believe it is appropriate to develop these in the freshman year (see Figure 1), and our alumni stakeholders often report on surveys that these are among the most important things to have learned at MIT [10].

A widespread concern was of the *quality* of these offerings. At an intellectual level, there is a “concern that we’d be teaching merely surface behaviors that mimic authentic processes and students will think they then know something that they really don’t.” Said another way, “will students think this is something ‘mickey mouse’ that was cooked up for freshman, unlike the core courses they know are serious.” It is “very different to do these courses with freshmen – you cannot take an upper course and just use it for freshmen,” and that faculty can get enthusiastic and “feel frosh can do much more than they’re capable of.” The solutions to these legitimate quality concerns include realism within bounds, ownership of the offerings, and an effective quality control mechanism.

Finally, almost everyone interviewed spoke in some way about a concern regarding *resources*. The “enormous preparation time for instructors,” the “equipment for each student – must we share?” and the scalability to hundreds of students were prime concerns. The scarcity of interested and qualified faculty was evident in comments like “How many profs are good at this?” and that the interested “faculty submit pilots, but that may change in the future.” Space, sustainability and scalability were all issues. There is no question that project-based courses are more demanding of resources than conventional lectures, more so if they are done as one-offs, each on the individual efforts of lead faculty. However models of effective large project-based course exist – at Cambridge about 300 first year students take one in Engineering each year. They require dedicated resources, coordination, shared materials, well-equipped and maintained spaces, and staff. They also require a change in faculty role, from lecturer to coach or mentor.

There were also a number of comments made that were not clearly benefits or detriments, but which nevertheless highlighted important issues. These issues fell into the categories: fit within curriculum, coordination and ownership; importance of student choice; differential investment of resources; evaluation and assessment; and faculty incentives and recognition.

The first of these issues related to *fit within the overall curriculum, coordination and ownership*. Respondents indicated that they were concerned that single project-based courses that are not part of a disciplinary program would not be well integrated into the curriculum. “It is important that such courses are coordinated with the other aspects of the freshman year. They must not be

stand-alone courses, especially considering the difficulty of having these courses without a fundamental base. It is important to take advantage of what is being taught in other courses, in order to not be repetitive.” There was also uncertainty over whether departments should compete to provide project-based courses or whether every department should offer one. The issue of ownership of the courses was a source of concern, should it be departments, schools or a coordinating or “regulatory” group.

There were various and mixed opinions expressed related to the absolute *importance of student choice*. Some think choice is inherently valuable, while others are concerned about dilution or lack of consistence in preparation for upper level courses. A reflection of the value of choice is that it shifts responsibility for decisions on learning to the students - “It is the students’ decision what to take if there is an option – they will have to think carefully.” There is learning from being required to make choices – students will “learn what they like and dislike.” On the other hand, some wonder whether choice is just an abrogation of the responsibility of the faculty to make effective decisions – “Would like the Institute to be honest at some level about how we go forward with this – is it really the best thing to do to give students some choice as opposed to the need to know core material, or is it because we don’t know how to teach the core compellingly?”

Again on the topic of resources, there was a separate issue raised as to whether investing in project-based courses was the best *differential investment of resources*, that is, given the significant investment that would be made in these courses, would the students not be better served by making the existing General Institute Requirements stronger? One respondent indicated that they “Hope that these project-based courses don’t detract too much from the need to put more resources into the GIRs – if the basic GIRs had more resources (people, money, energy, etc.) they could be made more exciting.”

Two final topics which received some attention of note are:

- *Effective evaluation and assessment*: “These should be considered an experiment and should be evaluated – were they a good idea that succeeded or a good idea that didn’t succeed?”
- *Faculty incentives and recognition*: some had a concern that there would be “no reward or incentive structure for the faculty” involved in first year project-based instruction. A similar concern was whether departments would “award teaching credit” to such activities.

Student Opinion Responses

Face-to-face interviews were carried out with 58 students: twenty current seniors for retrospective views; and new students for prospective views - twenty incoming freshmen, and eighteen high school seniors garnered at the admissions tour. They were asked slightly different questions.

One question was, “Given the opportunity would you take (or have taken) a project-based course freshmen year?” The responses were overwhelmingly positive; Yes – 48, No – 8, Depends – 1, Yes But – 1, where the ‘but’ was explained as “but *in addition to* the GIRs, *not instead of* a

GIR.” This support for a change is unusual among MIT students, who tend to be a conservative force in educational reform.

The students were also asked about the benefits to students of project-based courses. Their responses, which did not differ widely among the three groups, included “interesting/different,” “real world,” “hands-on,” “apply knowledge,” “check out or emphasize major,” and “not book work.” What did differ slightly among the groups was the percentage of students in each group making the response. (see Table 1) Prospective students were most interested in the novelty of the approach. With seniority, students became more interested in the link to majors and professions.

Table 1: Comparison of Stated Benefits of Project-Based Courses by Student Sub-group

Response	Prospective Students	Freshmen	Seniors
Interesting/Different	32%	9%	16%
Hands on	26%	14%	25%
Real world	21%	27%	16%
Apply knowledge	11%	18%	16%
Interactive/Not book work	11%	9%	-
Emphasize/Explore major	-	9%	25%

Faculty Responses: Expected Proficiency Levels of Learning Outcomes in Project-based Courses

In addition to being interviewed, respondents were asked to complete a survey. A survey tool [16] was developed to engage the stakeholders in setting the specific level of proficiency in various topic areas expected of students at the end of a project-based course. Forty-two faculty and/or administrators were interviewed in person and asked to complete it during the interview. Thirty-one usable, completed surveys were gathered.

The topic areas included in the survey were:

1. Problem Solving,
2. Inquiry Based Knowledge Discovery,
3. System Thinking,
4. Personal Skills,
5. Attitudes,
6. Conceiving/Designing/Building,
7. Teamwork,
8. Communication, and
9. External and Societal Context.

For each of the above nine topics, respondents were asked to consider the proficiency level they would expect from a first-year student at the end of a project-based course. The ratings available were:

- 0. Not applicable
- 1. To have experienced or been exposed to
- 2. To be able to participate in and contribute to
- 3. To be able to understand and explain

Some respondents declined to fill out the survey and a few “felt that trying define such strict and concrete learning objectives was contrary to the actual purpose of the courses, which is to stir excitement and creativity, not develop a potentially limiting set of skills.” However, the majority of respondents did complete the survey form.

As depicted in Figure 1, large percentages of faculty chose the highest expected proficiency rating, 3-Understand/Explain, for the areas of

- Personal Skills - 52% (including creative and critical thinking),
- Attitudes - 45% (including excitement for both learning and problem-solving),
- Communication - 40%,
- Teamwork - 35%, and
- Problem Solving - 34%.

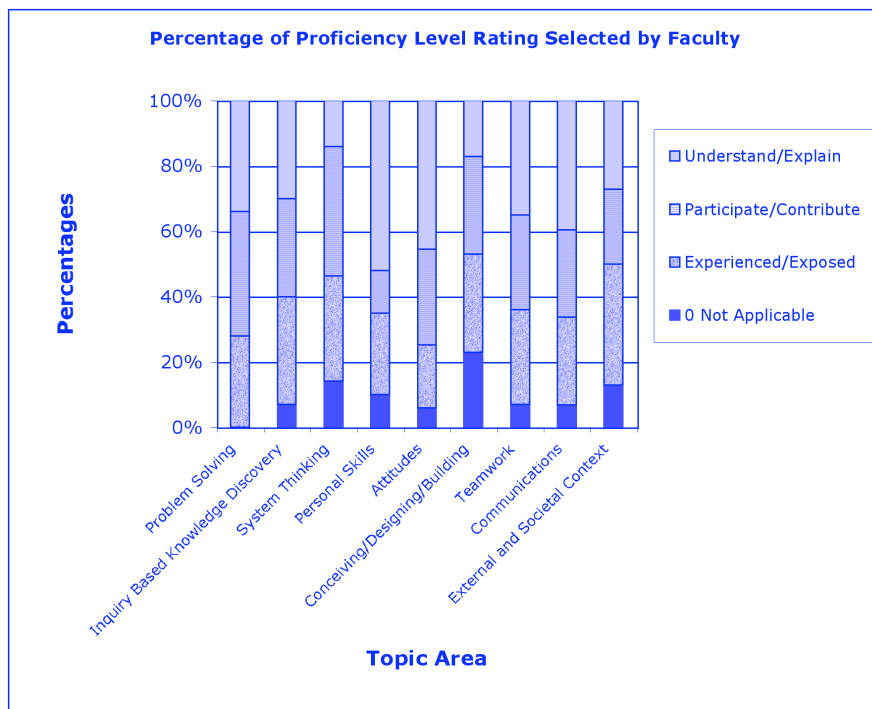


Figure 1: Percentage of Faculty Selecting Each Proficiency Level Rating

This result meshes well with the comments given in response to the interview question of “Assuming project-based courses are implemented, what learning outcomes would you like to see students leave the course with?” which was one of the questions on the opinion part of the survey.

Regarding the topic of Personal Skills, faculty hoped students would leave a project-based course with the ability to “critically analyze and design – this is what MIT is about,” as well as “critically evaluate – getting this going at an earlier level” while “gaining an attitude of curiosity & inquiry; look at a world of unknowns and do something about it” and having a “reflective self-awareness; an understanding of what education meant for them, how parts of education fit together, and why it is important for them.”

The Attitude-related objectives faculty hoped students would achieve included a sense of “humility – an appreciation of limits that are possible, not be crushed, appreciate little triumphs,” and a feeling that they had “taken on hard problems and met them with some degree of success,” while “maintaining the excitement they came in with.”

“Write a technical memo well,” and “not learn PowerPoint (viewgraphs) only, but other ways of technical communication” were two of the Communications objectives desired by faculty. Others were “read critically,” “write critically,” and “present results.”

Faculty viewed “these (project-based) courses are a way of starting to work in groups/teams, study groups” because being able to “work well with others - that’s the main one for our students’ was seen as very important. Faculty would like students to have “acquired some of the skills of effective teams, not merely participated on a team” and leave a project-based freshmen course “not being soured on the idea of teamwork.” This would entail careful planning of teamwork lessons and experiences to teach students how effective teams operate, the tools teams use, and the opportunity to practice and be successful in a team.

The final topic for which a large percentage (34%) of faculty chose the highest expected proficiency rating, 3-Understand/Explain, was Problem Solving. Answers to the interview question regarding desired student learning outcomes included “problem definition skills – how to define a problem in a non-narrow human way.” Faculty also hoped students would learn to “avoid analysis paralysis – don’t be paralyzed in the face of what to do.”

While the desire of having students reach such a high level of proficiency in these areas, may seem a lofty goal, those who currently teach freshmen and sophomores were the most optimistic about what could be accomplished. As depicted in Figure 2, for seven of the nine topics, faculty teaching first and second-year courses expected the highest levels of proficiency as compared to respondents in the other roles. Interestingly, the “Task Force” members, a group that also includes some other leaders of the faculty education efforts (Committee on Undergraduate Programs and Committee on Curriculum members) was often the most conservative group with respect to expectations.

Having commented on the distinctions in the expected proficiency outcomes, one might observe the overall impression that the expected proficiencies are not strongly distinguished. The dividing line between “participate/contribute” and “experience/exposed” only ranges from about 25% to about 50%. The authors interpret this to reflect a general lack of consensus among the faculty in the specific expected learning outcome of project-based first year course. This trend is present even among those who support project-based initiative. We would view this as a remaining opportunity – to develop among the faculty a more clear and common vision of the pedagogic and curricular outcomes of introductory project-based courses.

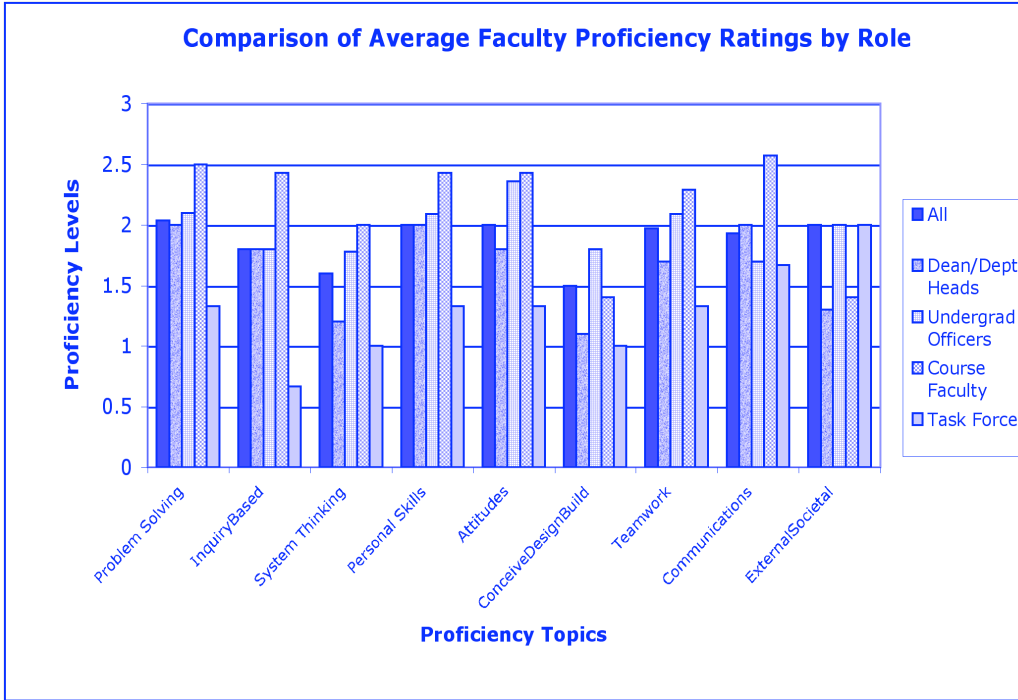


Figure 2: Comparison of Average Faculty Proficiency Ratings by Role

For a view into student perspectives, it can be seen in Figure 3 that as the maturity of the respondent increased from freshman to senior, the ratings expectations for proficiency decreased, which is typical of trends for student respondents to this kind of question. Only the expectation for Teamwork increased, perhaps indicating a desire among our students for a better foundation in this important skill early in their MIT career.

Summary

The benefits identified by the qualitative responses of the faculty generally support the propositions of the Task Force, and the experience with project-based courses at MIT and elsewhere. In summary, the benefits include:

- The role of such courses in attracting, exciting and motivating students
- The rich opportunity project-based learning provides for students to learn important life and professionally valued skills, including modes of thought (problem solving, creative and critical thinking), important attitudes and pre-professional skills
- The importance of introducing students to the context of the professional domain of practice
- The pedagogic value of helping construct a cognitive scaffold to support deeper learning of further, more abstract fundamentals, a benefit that is not as well recognized as its value might suggest.

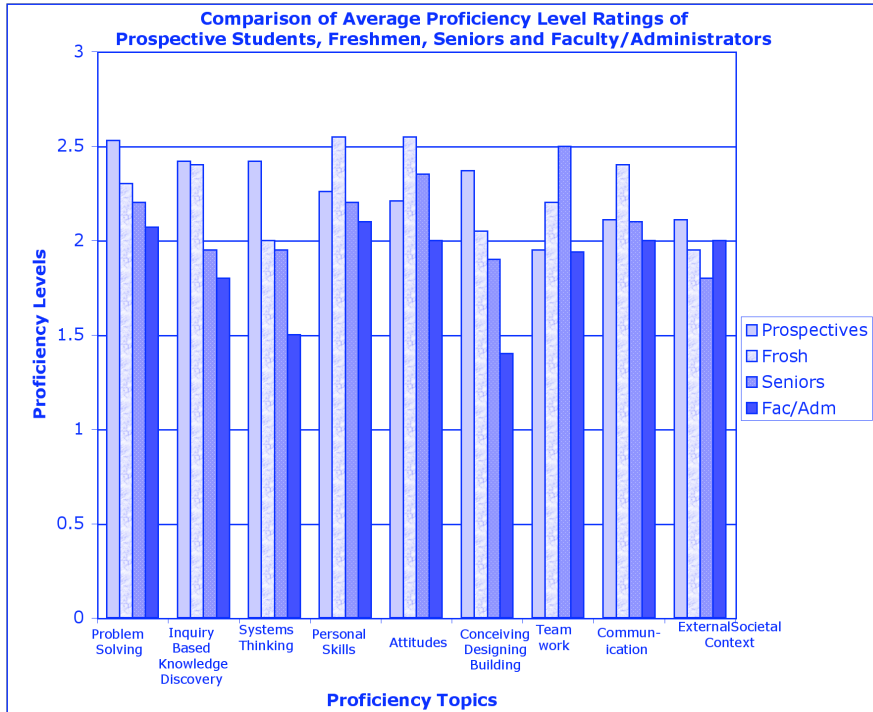


Figure 3: Comparison of Average Proficiency Level Ratings of Prospective Students, Freshmen, Seniors, and Faculty/Administrators

The detriments identified by the stakeholders are all legitimate. Some are more matters of priority of investment or resources, but all must be considered in the implementation of the Task Force recommendations. Key among the detriments are:

- The potentially adverse pedagogic impact on students, who may not be prepared for projects or who may not learn well in this style
- The tension over curricular resources and time – is this the best way to invest the scarce resource of requirement courses and student time.
- Concerns for the quality of the delivered education. Can it be delivered in a sustained and scalable manner, and will there be ownership?
- A widely held concern regarding resources – faculty, space, staff, etc. and whether there would be adequate resources to ensure the job is done “MIT well.”

A number of other issues were raised that are not explicitly benefits or detriments, but which should be considered in implementation. Among these is the need to coordinate the project-based courses with the rest of the curriculum and the debate on the importance of giving students wider curricular choice. Some faculty expressed the opinion that given the resources that would be invested in project-based courses, the equivalent investment in the existing GIRs might produce better net outcomes. Finally faculty voiced opinions on the need for effective evaluation and feedback, and appropriate incentives for those who teach such courses.

The quantitative responses for expected proficiency in skills at the end of the project-based experience do not reflect any strong differentiation, i.e. there is not a strong consensus that skill X should be emphasized. This probably reflects that there needs to be more sharpening of the expected learning outcomes by subsequent discussion. Among the topics for which there was generally higher expected learning outcomes are personal skills such as creativity and critical thinking, mature attitudes, communications and teamwork. However, there is broad consensus that all of the skills should be learned at something near the level of “2) To be able to participate in and contribute to,” which itself is a high expectation for a first year course. As an indication of hope, those who currently teach freshmen and sophomores were the most optimistic about what could be accomplished.

The student input was also hopeful, and perhaps indicated a potential emphasis on teamwork. The vast majority of prospective MIT students indicated they would be interested taking such a course.

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