LISTENING BY DESIGN:
TEACHING STUDENTS TO BE MORE COLLABORATIVE

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ABSTRACT

Engineers work collaboratively most, if not all, of the time. Yet even the most successful among them can be hindered by suboptimal teamwork. Successful collaboration is often seen as a matter of luck or innate talent. This paper describes a project that attempts to teach its essential components, in an academic setting, in a meaningful way that translates to a lasting increase in effectiveness. MIT undergraduates in team-based engineering and science courses were given a combination of lecture, workshop, introspection, and game activities woven into their collaborative technical work. Survey data indicate that more than 70% of the respondents reported useful learning about such essential collaborative behaviors as speaking up effectively in a group, learning about others' points of view, and functioning well together under pressure. In a reflective writing exercise, students expanded upon these findings, describing concrete improvements in their teamwork. The strength of these results suggests that students not only learned information about collaboration, but more importantly that they began to put that information into practice in circumstances that directly affected the success of their engineering work. Further work will include developing more robust outcome data and longitudinal follow-up.

KEY WORDS

Collaboration, teamwork, leadership, communication

LISTENING AND COLLABORATION: BACKGROUND

> People have always said I'm a terrible listener, and I always thought they meant I should just *shut up* more. But I just realized they meant I should…you know… *listen*! And find out what other people *really mean*!
>
> MIT undergraduate in 6.141,
> *Robotics Science and Systems*

Being an effective collaborator has become an essential quality for student engineers to cultivate; it seems a given that much of their professional lives will be spent working on teams. A Google search for books on "collaboration" yields 12,154 titles, suggesting among other things that collaboration is a significant topic, and that there is no clear, reliable path to achieving it. Organizations large and small struggle with the productivity of their teams: some fail outright, and many more underperform. Some teams that appear to be productive may in fact be missing significant opportunities of which they remain unaware.

Over the course of 16 years of consulting to teams in industry, my colleagues and I asked several thousand employees what they thought was ineffective in their teamwork. The most common answer was "communication." Indeed, the core work that we did was most often to open up avenues of communication for our clients. In particular, we sought avenues to help them hear each other: not necessarily to agree, but to move closer to understanding each other's views in order to have useful conversations about how to improve their collaboration. Many of our clients said, in one way or another, "I wish I'd learned this in college."

Collaborative work is frequently built into the design of MIT's undergraduate courses, in line with this apparent trend in industry. Statistics measuring the trend are elusive; however, a 2007 study by Professor Benjamin F. Jones of the Kellogg Business School analyzed 19.9 million peer-reviewed scientific articles from the past fifty years and showed that teams have been producing an increasing proportion not only of research in general, but more importantly of highly cited and "exceptionally high impact" papers, across multiple disciplines. Collaborative teams were more than six times as likely as single authors to produce the most successful papers, those cited at least 1,000 times. This suggests, says Jones, "that the process of knowledge creation has fundamentally changed." [1]

To these collaboration-based courses, our students bring a range of team experiences from sports to hobbies to student government. Some of them are wonderfully adept at collaborative work, and many of them are not. As one MIT student's feedback claimed about a particular course, "It can be a good experience if you're on a good team." But being on a "good team" is seen as a matter of luck rather than ability.

In 2010, MIT's Alumni Class Funds gave me a grant to design a set of modules that could be incorporated into existing team-based courses to teach students to listen to each other more effectively. The project was titled Listening as Exploration: The essence of collaboration.

This paper reports on the progress of that project over three years: successes, questions, and next steps.

LISTENING "MORE EFFECTIVELY": THE EMERGING DESIGN

The goal of Listening as Exploration was to "[t]each undergraduates to listen more effectively, making them more successful in collaborative work." Meaningful, lasting improvement was sought, that would be reflected not just in knowledge but in behavior, and specifically in behavior under duress. People will quite readily change their behavior to some extent in a classroom exercise; learning to be more effective in actual, uncomfortable and uncertain life situations is what this project attempts. It is hoped that the data compiled to date give some indications of success.

The design of the project grew out of a firm conviction, based on extensive experience, that such improvement in communication—meaningful and lasting—is possible. A second key assumption of the design was that achieving meaningful improvement depends on experiential, as well as intellectual, learning.

Initially three learning modules were proposed. The first looked at issues of self-awareness and self-management. The second addressed empathy, attention, and engagement. The third presented basic principles of negotiation. While the modules have since morphed significantly, those issues remain fundamental.

Two constraints inherent in the project's design led to the two greatest challenges: winnowing down to the minimal essential material, and packaging that material so that its delivery would be successful for the audience of MIT undergraduates.

Selecting the Right Material: *Communication Principles*

Because the project's modules are being designed as add-ons to existing, tightly-scheduled courses, they need to be brief. The current version of the project has only two modules, requiring about 75 minutes of class time coupled with some take-home work. The material has been shaped by an extended process of elimination, and experimentation with its selection and timing is ongoing.

A main anchor for the selection process was the work of Dr. Daniel Goleman on Emotional Intelligence (EI) [2]. Its premises make intuitive sense and are somewhat familiar to students, and its foundations and implications are being upheld by current research in neuroscience and behavior.

From that starting point through the initial iterations, some general principles emerged as guidelines for what to include. Specifically, components of the material were selected to illuminate intertwined propositions such as these:

1. Collaboration is an exploration in which we are all engaged; each of us brings strengths, weaknesses, skills, and uncertainties to it.
2. The nature, development, and experience of trust are at the heart of optimal collaboration. [3]
3. Communication, collaboration and teamwork do not lend themselves to magic formulas; instead, they require willingness to experiment and to persist through failure.
4. Our brain evolved for survival; it makes instant assessments of danger, which can run counter to the needs of collaboration. [4]
5. Our perceptions of each other—and our consequent behavior—are shaped by our experience. [5]
6. Influential people demonstrate five key characteristics: ability to listen, flexibility, interest in others, openness, and empathy. [6]
7. The tools that will help us when we become helpless are, largely, tools we already know: what we need for the most part is not to learn them, but rather to learn how to remember to use them when they seem irrelevant or immaterial.
8. Almost anything can be solved by communication, but solutions may not emerge in a predictable way.

The content of the modules and, more importantly, their delivery and all the work that students produce as a result of them, should convey the experience of one or more of these principles.

Making the Experience Palatable: Pedagogical Principles

The second overarching challenge of the project has been that the learning experience has to be acceptable to (and preferably welcomed by) MIT undergraduate scientists and engineers, wonderful students who tend to be some combination of smart, skeptical, practical, intellectual, appreciative, impatient, and droll.

Thus, the design and delivery of the modules have had to hew to pedagogical standards for active, student-centered learning that are continually refined [7, 8, 9, 10].

1. Delivery should be challenging, and preferably fun.
2. Instruction should proceed from a foundation of trust and mutuality.
3. Class time—whether lecture, introspection, exercises, or discussion—needs to move at a brisk and compelling pace.
4. Content has to be scientifically credible and intellectually honest.
5. Lessons have to be clearly and immediately practical, applicable to students' current problems.
6. Discussion, exercises, and examples must not be embarrassing, and public participation must be optional.
7. Food helps.

These standards have been checked against, and largely upheld by, discussions on MIT's Educational Collaboration Space, an interactive opportunity for instructors to compare notes on effective pedagogical strategies. In addition, students both present and former have been generous with their ideas and feedback. In summary, undertaking to teach collaboration in a meaningful way has been a collaborative process.

STRUCTURE AND CONTENT OF THE CURRENT MODULES

The current design of Listening as Exploration has seven components, woven together around these layers of meaning, teaching, learning, and experience. Each is briefly described below.

A Self-assessment

At the start of the term, students fill out an assessment of what they want or need to learn about teamwork. The assessment lists 48 items that relate to the main purposes of the modules: self-awareness and self-management; empathy, attention, and engagement; and ability to negotiate. Students are asked to rate each item "1" for "I think, I've been told, or I wonder whether I need to work on this"; "2" for "I need to work on this"; and "3" for "I really, really need to work on this." Because commitment is sought, rather than agreement, a Likert scale is not used. The tone is intentionally informal and personal, so that the assessment feels conversational rather than clinical. The items are interrelated and somewhat redundant.

Table 1. Sample items from the self-assessment

Motivate my teammates to do their best.
Plan adequately so that time is well used.
Seek out and learn from others' points of view.
Help my team make good decisions.
Make sure everyone is contributing fairly.
Delegate so that tasks are done efficiently and everyone learns.
Make and manage effective team agreements.
Make sure roles and responsibilities are clear, and wisely assigned.
Behave respectfully towards others, whether or not they are present.

The assessment is designed to induce students to consider the wide range of behaviors associated with good collaboration, some of which they no doubt already possess, others of which might not be obvious. It is hoped that some of the items seem surprising or unexpected. Reading the list of items should expand students' notions about how many kinds of skill and ability are within the scope of this exploration.

The assessment can reveal patterns in the teams' goals, for example a team whose members all say they need to learn more about "how to speak up in a group." In addition, students revisit these assessments later in the term, choose items on it with which they feel they have not yet made progress, tackle them with their teammates, and report on the outcome. This iterative use of the assessment is intended, among other things, to give students an experience of bearing some of the responsibility for their own learning.

Finally, the assessment gives students a chance to share their goals, insofar as they are willing, with their teammates. Letting their colleagues know what they want to work on can be a fruitful component of good teamwork; it has yielded some productive discussions, while expanding the team members' sense of trust and camaraderie.

A 30-minute Slide Lecture

The first lecture is designed to set a bold but friendly tone, to evoke curiosity, to convey basic information about collaboration and emotional intelligence, and to begin to build trust. The foundation for its success appears to be that it is participatory: it is built around an exchange of experience, opinion, and inquiry.

Its topics include the case for collaboration; the challenges of listening; the Emotional Intelligence framework [2]; the role of emotion in science and engineering; the dilemma of being both unique and ordinary; the "fight or flight" impulse and its affect on relationships [4]; and the importance of self-awareness in making judgments.

A Second Brief Slide Lecture Leading into an Exercise

The second talk opens with a debrief with students about their teams. It then examines trust; perception and bias; the "ladder of inference" [5]; planning; and basic communication tools. Its central principle is that there is no "correct" way to solve a team problem or optimize a team endeavor; there is only the process of building relationships and experimenting to see what works to optimize them.

The "Preventive Guidelines" Exercise

Following the second talk, students work with their teams to arrive at a set of guidelines to prevent common team stresses from impeding their work later on in the term. They are asked to determine what measures they will take if (a) someone isn't fully participating, or (b) the workload isn't being fairly shared. Because these issues are familiar, students see their guidelines as real, potentially useful documents, and productive discussions ensue. Since time is limited, their actual guidelines are of varying degrees of utility, but starting the conversation is considered inherently valuable.

An added result of the guidelines process is that, in designing them, students can discuss with each other some of their experiences on teams; their patterns of behavior when their workload

intensifies; what kinds of support they find helpful; and what they might do when a teammate is slacking.

Finally, the guidelines demonstrate the value of preparing for the more common team problems, as students begin to see that proactively anticipating these problems can prevent them from occurring in the first place.

Bu-bu-bu-[communication]-Bingo!

Simultaneous with the task of creating their Preventive Guidelines, students are asked to play a game of what 2012 robotics students named "Bu-bu-bu-[communication]-Bingo." A variety of cookies is set out on a table, one box for each team, and Bingo cards are distributed. Students are told to work the Bingo card while they have their Guidelines conversations; whichever team gets the first Bingo gets their first pick of cookies.

The Bingo card is five squares by five, each square containing a single communication tool that can help facilitate a team's communication. The tools include both simple options such as "Ask a question," and more sophisticated ones like "Frame: lead with your intention or concern." They rely on careful listening, and many of them, such as "Withhold judgment," offer practice in demonstrating emotional intelligence.

While students generate their Preventive Guidelines and play their Bingo cards, they tend to relish the competition, have fun, and come up with at least the start of a plan for managing themselves during the course of the semester. They may or may not use the tools "correctly" or find guidelines that will be effective. But the experience is memorable, they refer back to it all semester, and the cookies get claimed.

Finally students debrief. Not surprisingly, they learn a great deal from each other. Some of the students later report that they found the whole process suspect until they heard their peers engage with it and identify valuable learning.

A Mid-term Check-in

Midway through the term, students are asked to revisit their self-assessments to identify a few areas of teamwork that they said they wanted to improve upon, but that they haven't yet addressed. They are asked to pick out a couple of tools from the Bingo card (or elsewhere) that seem likely to shed some light on their targeted issues, try them, and report back in an email.

This exercise reminds them, in the midst of their engineering work, of the existence of the teamwork portion of the course. It reminds them that they are responsible for their own improvement, and that they have tools and resources available. It also can uncover students or teams that might be struggling under the radar, so that we can actively intervene.

When this exercise is debriefed in class, it deepens and broadens students' understanding and experience of this component of the course.

A Final Self-assessment

At the end of the semester, students are asked to repeat the self-assessment they did at the start of the term, rating the same items as "1" for "I wish I had been taught more about this"; "2" for "I learned about this"; and "3" for "I really, really learned something valuable about this." The

students' final self-assessments have often been very different than their initial ones. Frequently, students would say they had learned a great deal about something they'd shown no early interest in. Overall, these assessments indicate that the program is proving useful to students at least during the course. In addition, they reinforce what the students have accomplished. It is hoped that their taking the assessment helps them confirm that the learning was a part of an ongoing process.

IMPLEMENTING THE MODULES: EXPERIENCE TO DATE

In Spring 2012, the first version of these modules was delivered in 6.141, Robotics Science and Systems, a fast-paced class where students design and build robots in 8 teams of 4. In particular, the combination of the Preventive Guidelines assignment with the Bu-bu-bu-Bingo game was offered for the first time. In addition, the mid-term follow-up provided anecdotal evidence of value.

As the modules were developed, portions of them were offered in 2.009, Product Design Process, and in 8.13, Physics Junior Lab. Although student responses were quite good from both of those iterations, because they are partial they are not included here.

Following are selected responses from the two sources of student feedback from 6.141 in Spring 2012. The first Table shows, a sampling of responses to the request to experiment with a few collaboration tools and report on their discoveries in an email; the second Table shows a summary of most significant results on the final self-assessment.

Table 2. Selected anecdotal results from the first 6.141 iteration

[W]ith my multitude of questions, I think I helped my teammates become more confident in what they had done.
I am generally quiet and reticent…. when I ask more questions, I have better understanding of where my teammates are and they also have a better understanding of where I am
Another thing that has put me more at ease is seeing some of my teammates frustrated at each other. I know this is generally bad, but it… has made me feel less awkward, as if I was not the only one not fitting in.
I've decided to work on withholding judgment and trying on someone else's point of view…. I am working on another group project with a friend, and while we have a lot of philosophical differences, I am trying to remember that there are some ideas he has that could definitely be helpful to my life, so I am trying to be less biased and listen to his point of view.
…people would just trust me in high school. At MIT, everyone's pretty adamant that they are right and don't blindly trust others; it was initially quite frustrating that people wouldn't just bend to my suggestions, but I've since learned how to persuade people [better]
I've tried to become more careful with blaming others. Instead of telling my team they did something wrong, I tell them what I would have preferred to have done and why.
I've also felt that I've gotten to know and understand my teammates better over the past week as we continue to work with each other more. I think this has resulted in more efficient uses of our time in lab.

The final self-assessment was not built into the 6.141 syllabus in time to require it of students. Nonetheless, 18 out of 32 students responded voluntarily. The following items are those with the highest percentage of students saying they learned either "something," or "something really valuable."

Table 3. Selected results from the 6.141 final self-assessment

TEAMWORK	2 & 3*
Speak up more easily in a group	89%
Voice my ideas in a way that helps move things forward	89%
Ask for what I need	83%
Plan adequately so that time is well used.	83%
Collaborate actively with teammates through frequent communication.	83%
Manage tasks more effectively	78%
Be open to others' ideas	78%
Help my team make good decisions.	78%
Help other people to do their jobs	72%
Be more patient	72%
Know when to listen and when to speak	72%
Avoid preconceptions by asking lots of questions	72%
Make sure roles and responsibilities are clear, and wisely assigned.	72%
Listen carefully and ask questions to make sure I understand.	72%
Stay positive under pressure.	72%
Help the team make effective decisions that everyone supports.	72%

* Eighteen out of 31 students responded. A "2" meant "I learned about this." A "3" meant "I learned something valuable about this."

Anecdotal, self-reported, and voluntary feedback are not as substantive as would be desired in order to claim meaningful improvement for students participating in this project. But the specificity of some of the anecdotes, together with the strength of the assessments—even among a subset of 58% of the 31 participating students—suggests that more exploration would be worthwhile. Even if the 13 students in 6.141 who did not complete the self-assessment learned nothing of value, the claim that 52% of these students learned something about how to "speak up more easily in a group," and to "voice [their] ideas in a way that helps move things forward," is promising.

FUTURE WORK: REFINING, TESTING, AND REPLICATING

In the spring term of 2013, the entire program has been delivered in 6.141 again, with all the pieces in place; substantial useful feedback is being analyzed. The program has also been incorporated into Physics Junior Lab, and a Physics graduate student is helping assess its effectiveness.

Refining the materials is expected to be an ongoing process. In addition, three particular challenges present themselves next.

Developing the Outcome Data

In the spring '13 iteration of the modules, students have been asked to participate in exit interviews, in order to get more detail about the meaning of their responses and the behaviors they represent.

In addition, in order to confirm the achievement "meaningful improvement," longer-term engagement and follow-up from students will be solicited, on a voluntary basis.

Effective teaching

The essence of this experiment, like the essence of collaboration, consists of generating collaborative relationships through listening, building trust and taking risks. Information about collaboration can be conveyed in a book or a video; by contrast, this project seeks to study collaboration through modelling and participating in it by way of authentically trusting relationships based in mutuality.

Several colleagues have expressed interest in working with the modules in the upcoming semesters; a collaborative endeavor should provide insight into how to teach it most effectively.

An effective internet presence

A web-based archive of ongoing research, readings, and video, including interactive space where students could share their ongoing questions and insights, would be invaluable as a resource as this work is developed. Some components of these modules may require personal presence and face-to-face interaction, but other components could certainly be produced and perhaps even enhanced online. In addition, there is a vast and growing literature on related subjects that could be archived. Finally, an online opportunity for students to explore and problem-solve with each other would provide a rich source of continuous learning.

CONCLUSION

Among the long-term goals of this project are to give students both experience and confidence in their own ability to generate complex, demanding, yet flexible relationships such as those that exist in successful collaborative work settings. It is hoped that their participation in these modules will deepen students' experience of the uncommon subtleties and richness of our ability to listen to and learn from each other, across projects, disciplines, and cultures.

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