How to Initiate Dialogue in Student Research Teams

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Abstract

In the process of integrating teambuilding training into a chemical engineering projects laboratory, we concluded that a pedagogical tool was needed to move the student teams through the early team life cycle and communication stages in order to create the needed trust to begin effective communication. The tool we developed consists of two parts: (1) an entrance questionnaire concerning attitudes towards working on a team in the laboratory class; and (2) a document in which the questionnaire responses are sorted and merged for each team, which we refer to as the "Initial Team Dialogues." The dialogues foster introspection and immediately force the students to deal with core behavioral issues, and they create an arena where the members can examine the function of their team as a unit.

I. Introduction

Effective communication between people has undoubtedly been an elusive goal ever since humans developed the ability for speech. The need for its attainment is especially critical in the development of high performing teams. Team building training is beginning to become recognized as an important element that should be included in engineering education. With this training comes the need for developing a means to enhance the rate at which effective communication can be developed between team members. The lifetime of student teams is short, and the team building training is only effective if the interaction between the team members can rapidly be brought to a meaningful state.

The context in which we have faced this problem is in teaching a project laboratory in the Department of Chemical Engineering at MIT in which students work on a project in groups of three. Although the concept of students working in groups in this course can be traced back about sixty years, initiation of team building training only began several years ago. Initially, we found that lectures on team processes were ineffective in promoting student collaboration, and we drew two conclusions:

     1. Team building training for engineering students should be highly contexualized to the point where it is an inseparable part of what is normally done in the course.

     2. A pedagogical tool was needed to move the teams quickly through the early team life cycle and communication stages in order to create the needed trust to begin effective communication.

We describe in this paper a methodology which has been successful in getting teams of engineering students over the initially awkward stages of poor communication. It begins with a

comprehensive questionnaire (taken before teambuilding training begins), which functions as a behavioral needs assessment concerning attitudes towards working on a team in the laboratory course. The responses to each question are sorted, merged, and returned to team members at their first meeting as a team. The document, which we refer to as the "Initial Team Dialogues," immediately launches the students into discussions of the most difficult issues about working together. The term "dialogue" is used because it refers to a particularly effective state of communication[1].

In order to provide the context in which these dialogues are used, there is a brief overview of the projects laboratory in Section II and of the team building training in Section III. The questionnaires and dialogues are described in Section IV, as well as the team ground rules that evolve from the dialogues. The role and impact of the dialogues in the team building training are discussed in Section V, followed by the summary.

II.   Overview of the Projects Laboratory

The Chemical Engineering Projects Laboratory is a required capstone subject taken by juniors and seniors who work in teams and gain hands-on experience in experiments that integrate material from their earlier subjects. The structure of the course is summarized in Figure 1. Each team works on a single, real-world problem (sponsored by an industrial company) with the help of an
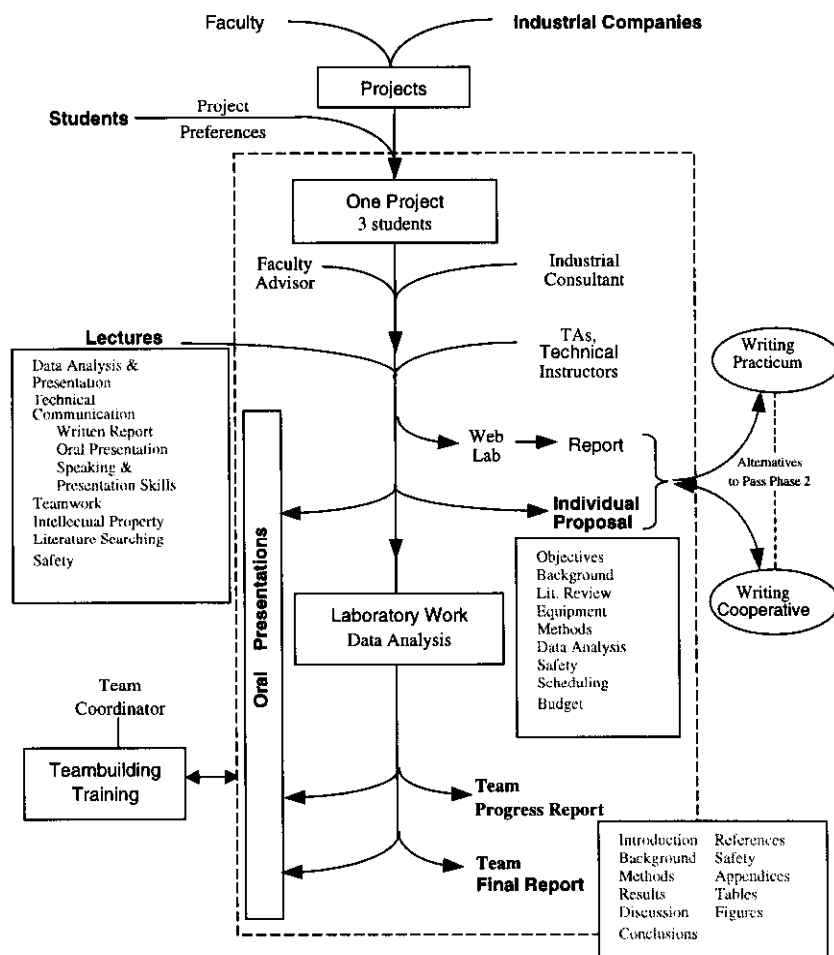

Figure 1. Structure of Projects Laboratory

industrial consultant and faculty advisor. Each student writes a technical report on a virtual experiment carried out on the World Wide Web and also prepares a team proposal that contains the goal and objectives, equipment, methods, data analysis, safety, and scheduling. Each student on the team also gives an oral presentation. Each team prepares progress and final reports in a formal technical report format. Lectures include data analysis and presentation, technical communications, teamwork, intellectual property, safety, and literature searching. Primary instruction is provided by frequent direct contact with the faculty advisor, teaching assistants, and technical instructors. A productive educational experience requires substantial effort on the part of both students and staff, and it is greatly benefited by the teambuilding training.

III.   Overview of Teambuilding Training

In order to prepare our students for their future work environment, we employ an advanced training program in interpersonal and team building skills that is highly contextualized throughout the course. The training incorporates a written manual, lectures and group exercises, and a structure for team communications, as well as ongoing monitoring and instruction of individual teams by a faculty team coordinator throughout the term. A separate workshop for faculty advisors and teaching assistants is held at the beginning of the course. The goal of the teambuilding training is to provide the students with the experience of a high-performing, self-directed knowledge team which utilizes formation of ground rules, shared team leadership, participative goal setting and clearly defined action plans, and effective conflict resolution and which is capable of enhanced flexibility, creativity, and decision making. Because time is limited, a highly directive style of team building instruction is used so that students can maximize their time on the technical portion of the course.

a.   Overall Structure

The structure of the teambuilding training is summarized in Figure 2. Teambuilding is emphasized at the very beginning so that the teams are formed and begin to function as the students begin to plan their project.

At the first class meeting, before the teams are organized, the students are assigned to fill out the "Structuring the Team" questionnaire on the World Wide Web site for the course within one day. At that class, students prioritize their interests amongst the projects offered. After class, the students are placed into three-person teams with common project interests with the goal of obtaining heterogeneity with respect to grade point average, gender, and ethnic background (where possible). Once the teams are formed, each student's response is sorted and combined by team into a document called the "Initial Team Dialogues". This document compares the responses of all team members to each question. It show the similarities and differences in viewpoint between team members and helps the teams formulate their ground rules. The teams members choose their rotating roles of oral presenter, team leader, or recorder. The dialogues are given to the teams at their first team meeting. Students identify the interpersonal abilities they wish to develop, learn how to form their team, brainstorm, and make decisions. Course specific exercises in brainstorming, decision-making, and facilitation are carried out. The brainstorming exercises relate directly to the team project. Students are taught how to develop a mission statement for the team and are instructed in the creation of team ground rules. Students
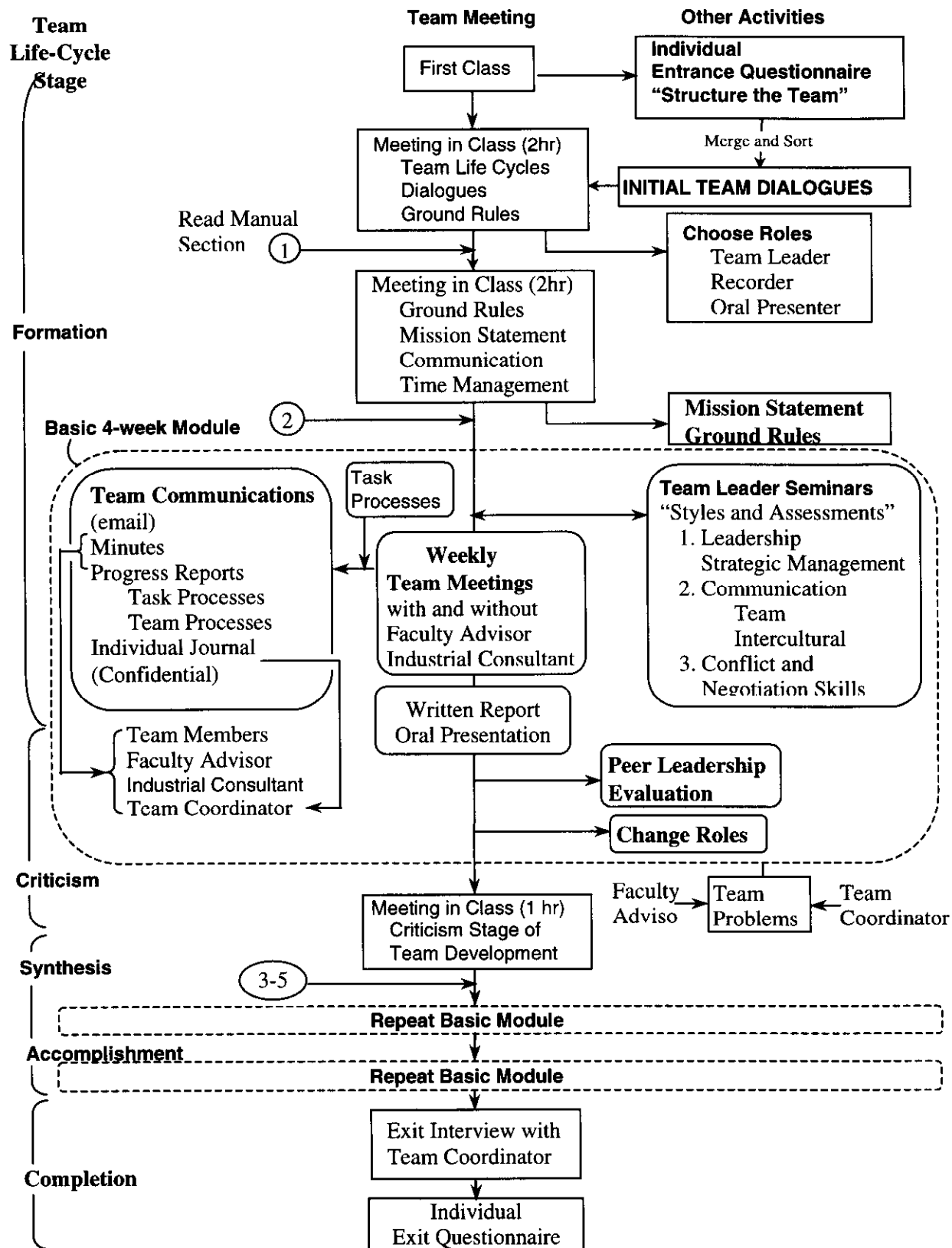
Team Life-Cycle Stage

Team Meeting

Other Activities

First Class → Individual Entrance Questionnaire "Structure the Team"

Merge and Sort

Meeting in Class (2hr)
Team Life Cycles
Dialogues
Ground Rules ← INITIAL TEAM DIALOGUES

Read Manual Section ① →

Choose Roles
Team Leader
Recorder
Oral Presenter

Formation

Meeting in Class (2hr)
Ground Rules
Mission Statement
Communication
Time Management

Mission Statement
Ground Rules

Basic 4-week Module ②

Task Processes

Team Communications
(email)
Minutes
Progress Reports
Task Processes
Team Processes
Individual Journal
(Confidential)

Weekly Team Meetings
with and without
Faculty Advisor
Industrial Consultant

Team Leader Seminars
"Styles and Assessments"
1. Leadership
   Strategic Management
2. Communication
   Team
   Intercultural
3. Conflict and
   Negotiation Skills

Team Members
Faculty Advisor
Industrial Consultant
Team Coordinator

Written Report
Oral Presentation

Peer Leadership Evaluation

Change Roles

Criticism

Meeting in Class (1 hr)
Criticism Stage of
Team Development

Faculty Advisor — Team Problems — Team Coordinator

Synthesis 3-5

Repeat Basic Module

Accomplishment

Repeat Basic Module

Completion

Exit Interview with
Team Coordinator

Individual
Exit Questionnaire

Figure 2. Structure of Teambuilding Training

are also introduced to team progress reports[2] which are filled out by the team leader after each meeting, as well as action plans, flow charts, and time management. The dialogues are passed out and explained to the students. During the first class meeting the students fill out an Interpersonal Competency Questionnaire and a Thinking Styles Questionnaire. The results are discussed in the next team class meeting. In the second team meeting, held during the next class, the dialogues are further explained in order for team members to perceive their specific team member role. Ground rules are established. A mission statement is created. Team progress reports have been filled out once, and feedback is given to each team on the completeness of their reports. Each member's thinking style is identified, and materials on thinking style interactions are presented.

By having the first two team meetings in class, the students are given instruction on how to build their team during the start up or formation stage which is critical to how effective the team will be in the other stages. The third team meeting in class is held several weeks later when many of the teams are in the criticism stage of team development. The meeting is used to go over conflict and negotiation skill development, review of the Initial Team Dialogues and ground rules, and exercises on how to maintain a team are presented. Diversity issues and conflict resolution techniques for dealing with anger and frustration in the workplace are discussed. Then an exercise on diversity and conflict management commences, followed by a discussion. The students are given an action plan for dealing with conflict within the teams. Developed by Dr. Hendrie Weisinger[3] as a mediating tool, it has proven to be an effective way of dealing with student frustration and anger within the teams.

Between the second and third meetings in class the students carry out a regular set of activities in the basic module (see Figure 2) which is repeated two times. The students are given the tools they will use to maintain their initial rapport. Their toolbox includes (1) weekly team meetings with a team leader who organizes agendas and a recorder who takes minutes, (2) team communications, usually by email, including weekly progress reports and confidential journals. The support staff includes the faculty advisor, the industrial consultant, and the team coordinator. Adjunct staff includes teaching assistants and laboratory support staff.

The team training includes a sequence of three, one-hour seminars for team leaders that focus on leadership, communication, and conflict resolution skills. The sequence of seminars is repeated three times during the term to coincide with the change of team leaders. The team leaders, recorder and oral presenters rotate after each oral presentation session and the seminars begin on the week when the roles change within the team.

At the exit interview at the end of the term, students discuss team process with the team coordinator. Each student fills out an individual exit questionnaire which shows what changes in attitude the student has developed.

b. Team Seminars

The first seminar covers leadership in a team. Prior to the seminar, students complete a goal/time management tool called The Strategic Management Model of Team Leadership Development[4]. The tool analyzes factors effecting goal completion such as power sources, personal skills as a leader, the environment, strategizing using the information technology

available at MIT, and preparing a leadership action plan. During the seminar, students are given instruction in situational leadership[5] contextualized to the course. In the second seminar, coaching techniques and intercultural communication are introduced. Role-play and other coaching exercises are presented. In the third seminar, a conflict management self-assessment tool is completed and discussed. Conflict management and negotiation skills, effective listening skills, and handling anger and frustration in a team are discussed. Team leaders have the opportunity to discuss any problems they are having building their teams.

c. The Team Manual

The manual is arranged by the team life cycle stages[6] and is summarized in Figure 3. The format insures easy access for each team leader using the manual. Each section includes a team assessment guide that the team leaders may use to guide their team through the specific stage the team is in during their leadership. The specific characteristics, the tools, and skills needed to build and maintain the team during the specific life cycle are described in detail. The focus of the manual is to make the team high performing.

IV.   On the Path to Dialogue

a. Entrance Questionnaire

The entrance questionnaire, entitled "Structuring the Team", relates to team organization and to the mind-sets of team members about their vision, goals, and objectives for the team. Areas subsequently covered in their team meetings are queried, i.e., laboratory work, written and oral presentations, interaction with the faculty advisor, team communication, team meetings, personal goals for the class, potential problem behavior, conflict resolution, interpersonal relationships and communication, and thinking styles. Each student fills out the questionnaire on the World Wide Web prior to beginning the training. The questionnaires for each team are merged and responses of all team members sorted so that they are listed together under each question.

What follows is an example of questions in one section of the questionnaire:

Goals
- What should be the team goals for your project?
- List your personal goals for the project.
- What goals would you put in place to maintain friendliness and cooperation within the team?
- How will you learn to work together?
- What team goals would you establish to grow in your interpersonal communication skills?
- How many hours will you have to spend each week to accomplish all of the team goals?
- What kinds of obstacles might you encounter reaching your goals?
- Do you need consensus to accomplish team goals?
- What technical skill sets and knowledge do you possess which will help other team members and the team accomplish its goals?
- What happens if you all decide you want to get an "A" in the course and then, because of time constraints, one of the team members decides that a "B" will be all right?
- What if this course is a higher priority for one or two team members than the other?

INTRODUCTION TO HIGH PERFORMANCE TEAMS   What is a Team?

Behavior that Fosters High Performing Teams

Team Life Cycle Stages	1. Formation
	2. Criticism
	3. Synthesis
	4. Accomplishment
	5. Completion

1. FORMATION

Roles and Tools for Your Team
Choosing the Team Leader and the Recorder
Progress Reports and Confidential Journals

Mission Statement
Creating and Maintaining Team Vision
Sample Statements from Previous Teams

Meetings
Efficient Meetings
Time Management

Ground Rules
Individual and Merged Questionnaires (Dialogues)
Using Initial Team Dialogues
Brainstorming and Formulating the Rules

Leadership
Leadership in Teams
Situational Leadership
Strategies for Decision Making and Planning Action
Team Safety and Security

Assessment of Yourself and Others
Thinking Styles
Emotional Intelligence
Leadership
Conflict Styles
Team Characteristics

2. CRITICISM

Communications
Communication Models for Communicating in Teams
Intercultural Communications
Preparing Team Reports and Presentations

Feedback   Forms of Feedback and How to Give Feedback

Listening   Effective Listening Skills - How to Listen and Respond

Conflict and Negotiation
Conflict Style Assessment
Intercultural Conflict
Emotional Intelligence - An Anger Action Plan
Negotiation Skills - Positional vs. Ethical Bargaining

Coaching   Coaching Styles - How to be a Good Coach

3. SYNTHESIS

Decision Making   Decision – Making Tools and Models

Team Maintenance How to Handle Relationship Difficulties
Return to Action Plans
Time Management

4. ACCOMPLISHMENT

High Performance Teams
Reviewing Your Competencies and Abilities
Action Plans that Include Individual's Personal Goals
Development of Team Conflict Styles
Producing Results with Team Progress Reports and
    Effective Meeting Agendas
Shared Leadership

5. COMPLETION Tasks for

Completion
Final Report Action Plan
Exit Interview
Time for the High Note
The Last Team Task

Each Section includes a list of tasks and skills needed to complete this particular stage of team development, a tool for assessing the team's performance in this stage, and comments on the appropriate leadership style in this stage.

Figure 3. Contents of Team Manual

- Is it all right for two team members to do more work in order to maintain an "A" commitment to the projects?

b. Initial Team Dialogues

The Initial Team Dialogues are the merged answers from the entrance questionnaire of each member. The dialogues summarize the perspectives of each team member. The dialogues are used to rapidly structure the team. The objective is to allow the members to assimilate, manipulate, and synthesize information and learn to communicate the knowledge collaboratively while applying their technical knowledge.

An example of one section of the team dialogue is presented in Appendix A, along with a complete list of all of the remaining questions contained in the team questionnaire. As is often the case, each student answered many of the questions differently. In question 5, "What team goals would you establish that would allow you to grow in your interpersonal communication skills?" Student No. 1 was very concrete in how he dealt with the question, Student No. 2, gave a more relational answer, dealing with issues of comfort and respect, and Student No. 3 gave a concrete answer . On this question the team can come to consensus quickly. All the students have the same goal in mind of allowing everyone equal time to present their views. The question is how are they going to make the goal happen successfully. . The ground rule that was generated from this question was as follows: "A 5-10 minute small talk session will be available at every meeting so that team members can discuss improvements and suggestions towards the overall progress of the project and our effectiveness as a team."

Another example of how the dialogues are used is given by question No. 2 which allows the team members to learn in an organized manner what the other team member's personal goals for the course are. They can then decide how they will be incorporated into the team's plan of action. Working in the laboratory together and having a public conversation can bring out some of the areas covered in the dialogues. It is more efficient having the information in writing and presented in relationship to one's own perspective. Being able to learn about each other quickly and nonjudgmentally allows a student to adjust his/her expectations and discuss them more openly, thereby establishing rapport.

Establishing ground rules are done at the first two team meetings and reviewed as problems or conflicts become apparent in the team. During the term, the dialogues are used to go over the ground rules, make adjustments, and come to consensus in areas where there is a difference in perspective. Ground rules support the team in making sure that all members understand the framework or structure of the team. Ground rules help to establish, clearly define, and develop mutual understanding about the team's culture. Laboratory process teams function in five major environments: laboratories, paper writing, individual oral presentations, communicating with a faculty advisor and/or industrial advisor, and communicating with the team coordinator. "Norms" (rules which will predicate how you will act as a team member) will need to be established in all five areas. The rules are in writing and distributed to team members, faculty advisor, and the team coordinator. The procedure to follow in order to formulate ground rules from dialogues is as follows:

Merge questionnaires into dialogues and use to establish ground rules
Make sure to cover all areas of team interaction and plan ahead

Decide which norms will support high performance
Reinforce positive ways to communicate support and utilize the team's strength to be high performing
Discuss team ethics
Make an agreement to help each other to meet the team's goals
Commit to fulfilling your personal responsibility
Commit to being on time
Commit to preparing materials in advance
Commit to sharing ideas
Commit to support each other in work

Figure 4 is an example of a set of ground rules generated from an Initial Team Dialogue.

V.   Role and Impact of Initial Team Dialogue

The dialogues were created to quickly establish an atmosphere of trust and understanding. They free the students' time and energy to be creative. Structuring the team quickly is the major challenge in engineering courses. The objective is to allow the members to assimilate, manipulate, and synthesize information and learn to communicate the knowledge collaboratively while applying their technical knowledge. Senge's (1994) interprets dialogue as communicating to share meaning. Physicist David Bohm described dialogue as a new form of conversation which focuses on bringing to the surface, and altering, the tacit infrastructure of thought.

The concept of dialogue as effective communication, allows a person to go beyond the judgement of people's perceptions of each other and allowing team members to effectively discuss how to research and to solve technical problems. The dialogues stimulate students to dig deeply into issues about the way they think, act, and communicate and how these characteristics will effect the team's performance in regard to creativity, problem-solving, and the ability for the team to use their technical knowledge efficiently and effectively. The dialogues teach students to listen effectively, clarify unclear areas of knowledge and behavior, and suspend judgment. Development of the ability to create a dialogue is a skill that takes commitment and practice to develop. The dialogues are further utilized by the students in the formation of the team. During the second stage of the team life cycle "Criticism" (also known as storming or orientation stage), emergent behaviors are analyzed, and the dialogues are utilized in our team building training again to understand the difference between their behavior and the consensual ground rules. Frequently, the students find that agreeing to change their behavior is only the first step in actual behavioral change. Extra support from the staff and faculty is given to the team to help the members. The dialogues help to create an arena where the team members can suspend their perspectives and look at the function of the team as a collaborative unit.

The dialogues delineate for the team those areas where communication is needed. For example, one or more of the members may have distinctively different perspectives on how the task should be accomplished (i.e. how many hours a team member expects to contribute to the task and what kind of effort they are willing to commit to the project). Students are taught to incorporate the areas of conflict into the next meeting's agenda where discussions can take place to effectively communicate the different perspectives on how the task should be accomplished. Seeing the differences in writing allows the team to come to consensus on logistics and strategy about the task.

General Rules
1. Always wear safety glasses in the laboratory.
2. Always be properly attired (no open-toed shoes; no shorts).
3. No horseplay in the laboratory.
4. Be on time for the meetings.
5. Have a formalized weekly team meeting to discuss the progress of the action plans.
6. Agree on a timetable of deadline dates that all members can meet.
7. Everyone must feel comfortable with all the groundrules.

Goals
1. Respect everyone's goals.
2. The group forum will be such that expression of ideas can be open and honest without fear of criticism from other group members.
3. Team priorities take precedence over individual priorities.
4. Majority will rule during conflicts.

Laboratory
1. All team members will agree on a schedule that they feel distributes the work evenly.
2. There will be weekly meetings in which we assess our progress against our goals.
3. If someone misses a deadline causing a setback for the team, the person who causes the delay will be responsible for his/her own actions and getting the group back on schedule.
4. Data will be recorded by whomever is present and able to record.
5. All members will have the opportunity to work with all the lab equipment and procedures.
6. To share equipment fairly among our own members and other groups, we will consult others for their deadline dates. We will then compare those dates with our own deadlines to work out a fair schedule. After using the equipment, we will also leave it clean for the next groups to use.

Oral Presentation
1. The two members of the team not performing an oral presentation will help the third person by sitting down and listening to their presentation before the actual date. They will offer constructive criticism and any help possible.
2. The outline for the final report and any data analysis will be produced together. Write-ups will be individual and then brought together for group analysis, editing and proofreading.
3. We will adhere to all guidelines.
4. The oral presenter will be responsible for the data book and papers judged to be relevant to our project. This is will be done to facilitate his/her oral presentation.

Faculty Advisor
1. Our advisor will serve the role of consultant to any of our group problems,
2. We will meet weekly (at a specified time and place) with our advisor.
3. The advisors, teaching assistant and industrial liaisons will be invited to attend team meetings. Their presence, however, will be optional.
4. We expect our advisors to respond to our questions in a timely manner. If they do not respond, the team leader will try contacting the advisors directly. If still unavailable, we will contact our teaching assistant, industrial liaisons, etc.
5. We will always put forth our best effort in order to meet our advisors' expectations. If, at any time, we fail to meet expectations, we will change so that we meet advisors' recommendations.

Team Leader
1. The team leader will be responsible for keeping the group focused and on-track. He/she will also be in constant communication with our faculty advisors to report our progress to them.
2. To encourage a free exchange of ideas, there will be no criticism of ideas. The atmosphere around the group will be such that speaking by ALL members is encouraged.

Communication
1. Face-to-face communication at the weekly meetings and during lab will be the preferred means of communication. However, emails and telephone calls will also be utilized.
2. Confidentiality should be respected by using common courtesy among team members.
3. If a person is quiet, the other team members should make an earnest effort to solicit his or her opinion on the project.

Meetings
1. Weekly hourly meetings should be held in the student center at a time that will be determined during lab or communicated via email.
2. If a person misses a meeting(s) or is consistently late, he or she must see Bonnie for more team building exercises.
3. Brainstorming will be done in lab or during weekly meetings.
4. Eating during meetings is okay and nobody smokes.

Conflict resolution
1. Conflicts will be discussed by team members in a cordial manner. If no resolution can be achieved, the advisors will be consulted.
2. To avoid outside conflicts, the group should make an effort to stay on-task and deal with matters that pertain only to the team.
3. Problems with our advisor will be resolved via open discussion.
4. Negative feelings will be expressed in a tactful way if at all possible.
5. To ensure that everyone's ideas are treated equally, we will respect all persons opinions.

Figure 4. Ground Rules

In addition, the dialogues delineate areas where decision-making tools can be used in order to come to consensus. When filling out the questionnaire, each team member frankly states his or her perspective. The team analyzes the results and may find that in many areas the team has already come to consensus. The dialogues give indicators of how each team member expects to perform in the team. In the next class team meeting, team members can describe the key performance indicators the team already possesses. Opening the team to dialogue starts the building process in a positive constructive manner by supporting frank, open discussion on how each person works individually and how they are willing to commit to working collaboratively. The dialogues also allow the team members to comment on the team's strengths and to constructively allow the team to decide how they will agree to work together in areas where they have different perspectives. Trust in the team is built by acknowledging every team member's work ethic and perspective before coming to consensus on differences in perception in the dialogues.

The dialogues enhance productivity by allowing the team to review improvements in planning, organization of writing assignments, oral presentations, communication amongst themselves and with the faculty advisor, setting deadlines, managing time constraints, showing up for meetings on time, and resolving conflicts. The dialogues further define the actions needed to develop the members' interpersonal competencies, including skill and knowledge level to gain proficiency in time management, laboratory and technical skills, and writing and oral presentation skill level. The dialogues aid in time management by directing the students towards achieving the objectives of the course. The dialogues organize communication within the team and with outside contacts making the team high performing.

The team leader can use the dialogues to seek agreement on changes in the team member's answers to conform to the goals set by the team. The goals are then organized so that they are specific, measurable, and realistic and include target dates for their accomplishment. Each team member is given specific goals to be accountable for during the semester. The dialogues highlight clearly and specifically areas of responsibility that are monitored by the staff and faculty.

The primary goal of the team is to become high performing. If behavior emerges that is discordant with the ground rules set by the team, the dialogues are reviewed. Often people agree to change their behavior. Unfortunately, the old behavior has become an unconscious habit. Good team management is periodically reminding members of these habits and their agreement to change. Discrepancies between the dialogues and the commitment to the ground rules can be seen in many instances. Students are encouraged as a team to always celebrate progress, and agree to take new steps to ensure the enjoyment and the fulfillment that comes from achieving objectives together.

The dialogues can also be translated into a business environment. In a company setting the team leader would create his/her own questionnaire, which would be situationally relevant to the team being organized. If the company has their own web page, the script can be created on the web for merging the results. The students in the team building training are given a formula for creating and developing a survey on their own for duplication in a business situation

At the end of the term, the students fill out the questionnaire again. There is invariably a large difference, which reflects their increased sophistication in teamwork. The dialogues support all the diverse objectives of the course by organizing the team for effective communication. The dialogues enhance productivity in activities ranging from management of literature searches to writing and oral presentation assignments. The dialogues make the students more open to listening and responding and to coordinating their talents into a set of skills they can use in the workplace.

VI.   Summary

Effective communication (open and honest, frequent, nonjudgmental, constructive) between team members is essential for high performing teams but is difficult to develop. We have constructed a pedagogical tool that is used to rapidly move the teams through the early team life cycle and communication stages.   The tool is a comprehensive questionnaire entitled "Structuring the Team" that relates to team organization and members' mind-sets about their vision, goals, and objectives for the team. Areas subsequently covered in their team meetings are queried, i.e., laboratory work, written and oral presentations, interaction with the faculty advisor, team communication, team meetings, personal goals for the class, potential problem behavior, conflict resolution, interpersonal relationships and communication, and thinking styles. Each student answers the questionnaires on the World Wide Web prior to beginning the training. The questionnaires for each team are merged and responses of all team members sorted so that they are listed together under each question. The merged questionnaire is called the "Initial Team Dialogues" (dialogues) because they initiate and accelerate the process by which each team moves along the continuum of communication stages towards that known as dialogue. The dialogues foster introspection and immediately force the students to deal with core behavioral issues. They help to create an arena where the members can examine the function of their team as a unit, allowing them to see that they have brought with them a variety of unexpressed assumptions, beliefs, and perspectives. The dialogues show them that they can choose to either defend or to suspend these assumptions and begin to listen to each other non-judgmentally without preconceived notions. The dialogues help the teams construct their ground rules by indicating where consensus can be reached immediately and where different viewpoints exist so that decision making tools can be used to come to consensus. The dialogues support frank, open discussion of each individual's strengths and weaknesses, working styles, and ways in which they can commit to collaborating together. They also serve as a reference point when discordant behavior emerges after ground rules have been established. Most importantly, the process initiated by the dialogues ultimately leads to a vehicle for enhanced creative problem identification and problem solving.

Acknowledgements

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Author Biographies

CLARK K. COLTON
Clark K. Colton is a Professor of Chemical Engineering at MIT. Dr. Colton has carried out extensive research and has approximately 190 publications in chemical engineering fields. He developed a pilot project to introduce team building skills into the chemical engineering Projects Laboratory in collaboration with Bonnie Burrell and he has continued to work with her to expand team work training into other undergraduate and graduate subjects.

BONNIE BURRELL
Bonnie Burrell is a lecturer in the Chemical Engineering Department at MIT. She is presently teaching team development to chemical engineering students. Since completing the pilot project started in 1997 she has been developing a curriculum in team work training that is being integrated into the chemical engineering curriculum from the undergraduate to the graduate course level.

Appendix A   Initial Team Dialogues

GOALS
1. What should be the team goals for your project?
Student #1 To work together in a cooperative manner such that the work that needs to be done is done (and done well).
Student #2 Team goals should include both project related goals as well as team work goals. For example, the team should have an idea about what the project objectives, they wish to explore. Team goals should also include working efficiently with each other, and listening to everyone's ideas.

Student #3 Our goal should be to learn the most possible, to learn to work well with each other, and get a good grade.

2. List your personal goals for the project.

Student #1 My personal goals for the project include to improve my interpersonal skills so that I can be more of a team player and work better with others.

Student #2 My personal goals include becoming a better public speaker as well as a more effective technical writer. In addition, I would like to learn more about specific chemical engineering principles related to the project I am involved with.

Student #3 1) to learn the most possible 2) to learn more about working with different types of people 3) to work well with my group 4) to get a good grade.

3. What goals would you put in place to maintain friendliness and cooperation within the team?

Student #1 Each person's ideas should be heard and discussed.

Student #2 I would set a goal to keep frequent communication between the team and cooperation to keep both parties informed on the progress of the project.

Student #3 1) everyone has to contribute at least 1 idea per group meeting 2) All ideas must be respected and each person must be given an equal chance to support his or her idea (i.e. cutting people off is not allowed.) 3) Allow 5-10 minutes in at least some, if not all meetings for small talk or complaint sessions. Its good for people to talk about ways in which they see possible improvement for the group come up.

4. How will you learn to work together?

Student #1 We will learn to work together by first getting to know each other--each person's strengths and weaknesses (and pet peeves)--so that we are a team of partners, not a group of strangers.

Student #2 I think communication is essential to working together as a team. In addition, team members should be open to ideas from everyone in the group.

Student #3 Learn each others personal styles (hard worker, determined, laid back, opinionated, etc.) and work to compliment these. Reflective listening is also good. For example, when someone gives an idea its good to say "So what your saying is...." If one needs clarification. The exercise gives insight into how each person thinks.

5. What team goals would you establish that would allow you to grow in your interpersonal communication skills?

Student #1 Each person should talk only one third of the time, and listen the other two-thirds of the time.

Student #2 To improve interpersonal communication skills, I would set a team goal that all members feel comfortable talking with any other member of the team. In addition, team members should treat everyone else with respect and be open to new ideas.

Student #3 For each meeting, every person should contribute at least 1 idea and try to respond to the idea of one other person. Allow one person to act as secretary for each meeting, and rotate this responsibility among all members.

6. How many hours do you think you will have to spend each week to accomplish all of the team goals?

Student #1 A few, maybe at the beginning, but it all depends on the team.

Student #2 I imagine that the hours spent each week on the team goals will vary slightly week to week. I think I will have at least 12 hours per week to work towards team goals, although I will work with my team as needed to accomplish our goals.

Student #3 15-25 hours (including class and assignment time)

7. What kinds of obstacles might you encounter reaching your goals?

Student #1 "Too many chiefs, not enough indians."

Student #2 Sections of our project may take more time than we anticipated. Team members may have different views on how the project should progress. Team members may have different grade expectations for the course and commit different amounts of time to the class. Our data may be unexpected and force us to change the focus of our project.

Student #3 1) conflicting goals/beliefs from other members 2) different backgrounds in terms of technical experience or group project work.

8. Do you need consensus to accomplish team goals?

Student #1 It is nice when everyone agrees to a particular point, but it is okay for one person to disagree as long as they are willing to let the project move along.

Student #2 Not necessarily. Team members may disagree on how to accomplish our goals, but we should reach a compromise on what is best for the group to accomplish to goals. A team member may not agree with everything the team is doing but realize that a compromise must be reached for the team to move forward towards its goal.

Student #3 Consensus is always helpful, but sometimes a majority vote may take precedence in the interest of keeping things moving. In that case, respect of the minority's opinion and address of their concerns is absolutely necessary.

9. **What technical skill sets and knowledge do you possess which will help other team members and the team accomplish its goals?**

Student #1 A pretty good familiarity with computers, and the learned ability to stay up all night without caffeine.

Student #2 I haven taken 10.467 (polymer lab) and have some knowledge of laboratory procedures related to polymers. I have also had an internship last summer at xerox, where I learned about toner processing and some particle size analysis.

Student #3 I've taken two other labs, 5.310 and 7.02. As a senior who has just completed 1st term ICE I have some experience working closely with groups on a technical project. My prior knowledge from 10.32 and 10.37 should also be helpful.

10. **What happens if you all decide you want to get an "A" in the course and then, because of time constraints, one of the team members decides that a "B" will be all right?**

Student #1 If we all decided beforehand that an "A" was the objective, then the person who now wants a "B" should stand by the agreement.

Student #2 Everyone at MIT is very busy. If one team member decides a "B" is all right, the other two team members may try to convince the third member to put all the time they can afford into the course, but also have to understand that many people's time is limited, and they may not be able to commit more than they are giving.

Student #3 1) All members should carefully go over the agreed upon goals and responsibilities set out at the beginning of the semester. 2) Ask why and when the time constraints for the "B" member occur. 3) Reach consensus on what the other members can do to help "B" member and his/her time constraints.

11. **What if this course is a higher priority for one or two team members than the other?**

Student #1 Regardless of priority, you should do your fair share as best you can.

Student #2 With different students having different priorities, team members can not expect anything more from their team mates than for them to do their best. The student for which the course is not their top priority should still be expected to contribute to the team goals approximately the same as the other members.

Student #3 When conflicts occur, the steps above should be followed if members feel that the quality of work of any member is being sacrificed.

12. **Is it all right for two team members to do more work in order to maintain an "A" commitment to the projects?**

Student #1 If a person wants an "A", they should be able to "go for it". The person with the lesser commitment should try to help, but shouldn't expect the same grade.

Student #2 While ideally, all team members will work equally towards the team goals. If two of the team members would really like an "A" they may have to work more than the third member to maintain that "A". Perhaps the two team members can ask the third member if they have more time to commit to the project, but not pressure that third member to do something they do not have time to do.

Student #3 Yes, if they are willing to and the third member can not will not commit to the time necessary. Hopefully, all three members would talk to the team coordinator before the problem got out of hand.

Conflict Resolution

1. **What will be the conflict resolution/negotiation style for the team?**

Student #1 Fight to death. Or open discussion, whichever works best.

Student #2 Conflicts within the team are probably usually best resolved by talking in a team meeting with the entire team.

Student #3 Always ask the question "what is your position and why?" then discuss possible solutions.

2. **What rules will you have about how to handle conflicts amongst team members?**

Student #1 Try to minimize personal conflicts in the best interest of the team.

Student #2 Conflict among team members may be handled by a third party talking to both parties and trying to come to a situation that allows the team members that allows the team members to still work together on the project even if they have differences.

Student #3 No cutting people off. .Listen to all ideas, then come to a decision.

3. **What rules will you have about conflicts with outside classmates and staff?**

Student #1 Think about the good of the team before doing anything rash.

Student #2 I think each person can handle their own conflicts with outside classmates or staff.

Student #3 Keep it within the group unless it aff4ects your work, if that is the case seek help with the team coordinator.

4. How will you handle conflict with your faculty advisor and industrial consultant?

Student #1 If there is a conflict between one team member and the advisor or consultant, then the other team members should try to minimize the conflict. If there is a conflict between the whole team and the advisor or consultant, then maybe outside mediation is in order.

Student #2 If a conflict exists with the faculty or industrial advisor, I think I would try to talk with the advisor and explain my point of view and why might disagree with his/her approach.

Student #3 Understand their point of view, consult with my team mates, and make decisions from that point.

5. How will negative feelings be expressed?

Student #1 Hopefully not all at once in a shouting match in an Athena cluster. If something is bothering you, you should try to let the offending person know before it gets out of hand.

Student #2 Negative feelings can cause problems within a team. Team members can disagree, but they should be respectful to the others on the team whether they like them or not.

Student #3 If they will be constructive to the group in terms of helping us to be more productive, they should be phrased like "I feel x when y happens".

6. How will all members' feelings and points of view be taken into consideration?

Student #1 By following the rule of listening to everyone's thoughts and opinions.

Student #2 Each person should remember that different people will react differently to criticism. If the team members agree to treat everyone with respect then even when team members have criticism for others, it is not taken personally.

Student #3 Make sure we listen to each other in its entirety as it helps efficiency and then helps the group reach consensus.

Here is the list of other questions on the dialogue, without the student responses:

General

How will your team make up ground rules for its operation?

How will you review distribution of the tasks in your project activities to determine if one person is given too much work to do?

How will you deal with the different work habits of the individual team members?

(Some team members like to get assignments out of the way; others like to work under the pressure of a deadline)

What will you do if one of your team members fixates on a particular idea and can not listen to the others?

How should rules be changed if someone is uncomfortable with a rule?

Laboratory

How will work be distributed?

Who will plan the schedule of work in the lab?

What will happen if someone does not follow through with his or her commitment to the team? (e.g., missing a deadline, not showing up for lab)

How will the progress of the project tasks be reviewed?

Who will record the data in the laboratory notebook?

What tasks will be rotated to insure all team members become proficient?

What happens if different team members have different competence levels in laboratory skills?

How will you develop a set of rules for the team regarding your adherence to safety standards?

What procedures will be established about sharing equipment between teams?

Writing and Oral Presentations

How will you support each other's oral presentation preparation?

How will you analyze data as a team?

How will you manage your time so that assignments are turned in on?

How will you organize team writing assignments?

How will your team help to prepare an oral presentation given by one of your team members?

How will you write your written reports so they sound like they are written by one person?

How will you decide what information goes in your written reports?

How will you break the writing tasks into portions and determine which portion each team member will work on?

Should you write an outline of the report together?

Should you create an outline of the writing process in order to assign the tasks?

Who will proofread?

Will you take turns editing?

How will you support a team member who is less skilled in writing than the others?

How will you keep track of the documents (e.g., literature papers, laboratory notebook, sections of reports, etc.) that you need and use in your project?

Will one team member be in charge of the technical content of the reports and another be in charge of the writing style?

How will you deal with conflict over writing style in your reports?

Faculty Advisor

Do you want your advisor to be a member of your team or to act as a consultant?

Should you treat your advisor as if he/she was your boss in a work situation or as resource?

Is it your responsibility to set up meetings with your advisor?
How often should the meetings be held?
Do you want a set time in the lab to see your advisor?
Do you want your advisor to attend team meetings?
How timely should the feedback be from your advisor when you have a spontaneous need for guidance?
What expectations should your advisor have of the team?
Should the expectations be in writing or verbally communicated?
What happens if your faculty advisor is unavailable for consultation?

Team Leader
What leadership positions have you held in the past and what knowledge and skills did you
use to be an effective leader?
If you are the leader, are there any specific organizational structures or systems you would use to organize your team for
maximum efficiency?
What extra responsibilities will the team leader have in the project, including the areas of laboratory work and written and
oral presentations?
How will the first team leader be chosen?
Should the team leader be the person communicating with the advisor or should all team members have some responsibility
to communicate with the advisor periodically?
How will you insure that team members will share information and ideas freely?

Communication
When should communication take place amongst the team members and what medium should be used in each
circumstances?
Is confidentiality about communications amongst team members a concern for you?
How should confidentiality in the team be maintained?
Will there be specific agreements about honesty and open communication?
What should be done if someone dominates the conversation?

Meetings
Do you have a preference for when the meetings are held?
How long should the meetings be?
Where is a good place to hold the meetings?
What happens when people are late to the meetings?
What happens if a team member misses a meeting?
What if several meetings are missed?
How will interruptions in meetings be handled?
How often should the team meet for brainstorming sessions?
Can people eat at meetings?
Can people smoke at meetings?