

**AC 2007-2940: ASSESSING FACTORS CONTRIBUTING TO UNDERGRADUATE
MULTIDISCIPLINARY PROJECT TEAM EFFECTIVENESS**

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Abstract

The Interprofessional Projects Program at Illinois Institute of Technology is a project-based learning experience with the learning objectives of strengthening multidisciplinary teamwork skills, improving communication and project management skills, and practicing ethical behavior. All undergraduate students must participate in at least two semester-long three credit hour projects. Projects vary widely in focus, including Service Learning, Entrepreneurial, Product Development and others; some projects have participating external sponsors. We are collecting data on ca. 36 - 40 teams each semester, enrolling approximately 400 students.

We have developed several strategies for assessing teamwork effectiveness: (1) a self-assessment of the extent to which each student feels that they have developed teamwork competencies, (2) a Knowledge Test of teamwork concepts drawn from the vast literature on teamwork, (3) a Team Excellence and Trust Survey, assessing perceptions of the team's functioning in terms of factors identified with high-functioning teams, and (4) judge's scores of teamwork functioning as assessed during end-of-semester presentations at which both formal presentations and exhibits are evaluated by a panel of 5-7 persons not associated with the teams.

During the past three years we have introduced various interventions to enhance teamwork functioning. Our first intervention included administering the Team Excellence Survey and providing a feedback/ action session with a subset of teams during weeks 5-8 of the semester. Over a three-semester evaluation period, team functioning overall was not significantly different between teams that received this intervention and those that did not.

We are currently evaluating the impact of an intervention designed to speed up the process of team formation by offering a half-day of team games and other activities specifically designed to focus on awareness of teamwork. We are comparing the performance of individuals and teams that participated in this experience with those who did not. In addition, recognizing the complexity of variables that affect team functioning, we will assess the impact of student background on performance in this area; namely, year in school, academic major, GPA, gender, country of citizenship, prior experience with a project team, prior formal instruction in teamwork, prior experiences in leadership positions, and expectations about the experience.

Results from the first trial semester (Fall 2006) indicate that students who attended and did not attend the games were similar on most demographic and experience variables. However, students who attended the games had higher average GPA, and felt more positive about the IPRO they were joining; they were also more likely to feel positive about their team functioning at week 5. However, participation in the games was not associated with any difference in mastering the knowledge base in teamwork, or in their self-assessed competence in teamwork at the end of the semester. At the team level, teams where at least one member attended the games were somewhat more likely to submit good initial project plans, and significantly more likely to submit a good Midterm Report dealing with modifications to the initial plans. Results from the second trial semester (Spring 2007) will provide further insights into this intervention.

1. Introduction

In order to prepare students to compete more effectively in the contemporary business workplace, Illinois Institute of Technology (IIT) has created the Interprofessional Projects Program – IPRO[®]. All undergraduate students are required to participate in at least two 3-credit multidisciplinary projects. Each semester 35 - 40 projects are offered; students select which projects they join. Each team is composed of 6-15 students and one (or more) faculty supervisor/coach. The teams work on a wide variety of projects; some are service oriented, some focus on improving processes, doing basic research, or developing products. Projects in the Entrepreneurial track (ENPRO) focus on performing new venture analysis, and typically include the development of a business plan. Some of the projects have external sponsors that provide intellectual and/or financial support, such as entrepreneurial ventures, non-profit organizations, government agencies, corporations, and academia. At the end of the semester all teams participate in IPRO Day, where each team gives a 20-minute presentation, and are available at their exhibit to discuss the project. Presentations and exhibits are evaluated by groups of judges.

IIT is a private university with five campuses in Chicago and its suburbs. Established in 1890, it offers undergraduate and graduate programs in many fields, but predominantly in engineering, science, architecture, law, business, design and psychology. There are about 6,200 students enrolled, many of whom are international students. Most of the students involved in the IPRO projects are juniors or seniors, though a few sophomores and graduate students also participate.

IPRO has identified the following four major meta-learning objectives: **1)** learning project management skills, **2)** developing effective communication competencies, **3)** becoming aware of ethical issues in problem solving, and **4)** working effectively on multi-disciplinary teams. These learning objectives are consistent with those recommended by the Accreditation Board for Engineering and Technology's [ABET] *Criteria for Accrediting Engineering Programs*.¹ We have been developing tools to measure the achievement of these learning objectives, guided by the recommendations offered by Immekus et al.² We have followed their method, first defining the desired learning outcome, identifying the sub-domains included and the skills that can be measured directly, with operational definitions measured in questionnaire items. The second step is to design assessment instruments and evaluate their reliability and validity. We developed an initial set of self-assessment instruments³ and have recently revised them; we are testing the revised versions for the first time this semester.⁴ Measuring teamwork is crucial if we are to evaluate the extent to which we are, in fact, developing teamwork skills, and to assess the impact of interventions designed to enhance teamwork skill learning. However, as Immekus et al. pointed out², the measurement of teamwork is especially challenging, since the sub-domains used to represent teamwork are inconsistent across studies, and most of the literature on teamwork comes from industry-based rather than academic teams.

Probably because effective teamwork is so important to workplace success, a good deal of research has focused on the personal qualities of team members, the kinds of interactions characterizing various types of teams, and the functional outcomes of different interactions. For example, LaFasto and Larson⁵ collected and analyzed responses from more than 6,000 team members and leaders to identify the characteristics of high-functioning teams. According to their research, successful teams integrate five dynamics: collaborative team members, positive intra-team relationships, productive group problem-solving, leadership that encourages collective achievement, and an organizational environment that genuinely promotes collaboration and teamwork. This provides one set of criteria by which to assess the team functioning, but does not provide a path to achieve positive outcomes.

Other researchers have explored the question of how teams develop. Probably the best known is the four-stage model of team processes proposed by Tuckman⁶: forming, storming, norming and performing. In the *forming* stage, team members get to know each other and cautiously test boundaries but are hesitant about jumping into action since they are still trying to figure out what the problem is and whom they can trust or wish to work with. The *storming* stage occurs when the team experiences turmoil and confrontation among members as they compete for authority in defining the problem and dealing with issues of trust (or mistrust) between members. In the *norming* stage, conflicts are resolved and members accept their roles and responsibilities; relationships then become more productive. The final stage, *performing*, occurs when the team members become comfortable with each other, settle into their roles and relationships, and become truly productive.⁷ A later meta-analysis of teamwork research affirmed these phases, and suggested an additional phase of *terminating*.⁸ One of the problems with the Tuckman model, in relation to the IPRO program, is that it is based on observations of groups that were established for conducting university-based research; these may be empirically different from corporate work groups, teams with different objectives, or from university-project teams of the type in our IPRO program.⁹

While a number of variations of the Tuckman model have been proposed, they introduce relatively minor modifications. However, Kur¹⁶ rejects the notion of linear-progressive stages altogether, and argues that teams present different “faces” at different times, asserting that teams can cycle, and recycle through the “phases” many times. Nonetheless, Kur describes similar phases of forming, storming and norming – with the same goal of getting to (or perhaps getting back to) the performing phase.

Many teambuilding interventions have been described, including: start-up interventions, regular formal reviews, addressing known task-related problems, identifying the problems, and social process interventions. We decided that the most relevant need for us to address is the start-up interventions, since most of the others apply more directly to teams that have been working together for a longer period of time.

The challenge then is to facilitate the early phases of team formation. In fact, there are dozens (perhaps hundreds) of guides to effective team building; most seem to offer anecdotal evidence of their effectiveness, and most are designed for work groups in the paid labor force. Their applicability to undergraduate teams such as those found in the IPRO program, and many similar programs at other universities, is yet to be determined. Our research is designed to assess an intervention based upon a set of team-building exercises.

In addition to understanding and measuring team functioning, the challenge is to teach teamwork skills and enhance teamwork functioning, particularly among young adults in a learning environment (e.g. college). Educators have long seen value in presenting ambiguous, real-life challenges to students to further the development of thinking and reflection.¹⁰ Several decades of research on similar learning processes designed to increase students’ depth of understanding has provided a base of knowledge represented by five key elements: active learning, frequent feedback from others also involved in the problem solving effort, collaboration, cognitive apprenticeship involving mentors, and practical application in tasks that have real consequences.¹¹ Since the IPRO program is designed to provide an experiential learning environment; a core requirement is that good experiential learning involves design projects requiring collaboration with others in an effort to solve practical problems.¹² By assigning specific projects to each team, the IPRO program utilizes all five key elements; students learn through actively working on their project, they must work together and

communicate with each other in order to reach their goal in the allotted time frame, faculty and outside sources act as mentors guiding the team throughout the semester, and each individual is required to work on a task which has implications that reach beyond the classroom.

While many field experience courses have been developed in higher education, the amount of high quality, systematic research on the long term learning benefits of such education is relatively scant.¹³ A significant step toward building a knowledge base in experiential education is identifying what works in the classroom (or project) and demonstrating the effectiveness of innovative practices. The research reported here will contribute to such a knowledge base.

In addition to desiring to add to the general knowledge base about how to assess competencies in teamwork, we are striving to implement assessment strategies that support student learning. Gibbs and Simpson¹⁴ summarized research on how assessment procedures support student learning. They argue that concerns with reliability of test instruments are less crucial than demonstrating that assessments support worthwhile learning. On the basis of meta-analyses of what makes a difference in student achievement, they identified 10 conditions influencing the volume, focus and quality of studying and learning. These conditions place an emphasis on having tasks which require ample time and attention so that learning might occur; receiving sufficient feedback, often enough and in adequate detail (focused on students' performance rather than on the students themselves and on their characteristics); timeliness (so that students have time to correct their behaviors); tailored to the purpose of the assignment and its criteria for success; appropriate in relation to students' understanding of what they are supposed to be doing; and assuring that the student receives, attends to, and acts upon the feedback. One of the fundamental goals of the IPRO program is to ensure that students are retaining and utilizing the desired learning objectives. As outlined by Gibbs and Simpson, to best measure whether this process is occurring, we provide students with feedback about their performance both as an individual and as a team. This is done through disclosing their scores on measures testing students' understanding of the learning objectives and sharing feedback on their performance during IPRO Day. We also assess whether the student acts upon the feedback by again testing their knowledge of the same learning objectives at a point later in the semester.

There is little consensus about the best strategies for developing such competencies among undergraduate students. Our first intervention protocol was based on one developed for business use by a consulting firm (St. Aubin, Haggerty Associates Inc., 2004)¹⁵ based on research by LaFasto & Larson.¹⁶ The protocol was developed for use in industry with teams of four to fifteen members who have been together for at least six months. While our IPRO teams did not meet these criteria, we thought it would be worthwhile to test it with a student population. This intervention involved administering a team excellence survey during the early part of the semester (e.g. weeks 4 to 6), presenting feedback to teams that identified existing team strengths and "developmental opportunities" (i.e. weaknesses), and conducting a facilitated discussion with the team about constructing an action plan to deal with the perceived problem(s). This intervention was designed to provide relatively rapid feedback about team functioning, and to help team members understand more fully how individuals can influence the behaviors of their teammates. However, over a three-semester assessment of this intervention, the conclusion was that the teams receiving this brief facilitated reflection-planning intervention did not function more effectively overall than those who did not receive this intervention.¹⁷

We were (and are still) interested in improving teamwork functioning. While the just described approach did not seem to merit universal adoption, we were very aware that many teams do not function well. On the basis of much observational and anecdotal evidence, it was

clear that one of the major problems in team functioning arises from the fixed time structure imposed by an academic schedule based on 16-week semesters. Even though some projects extend over more than one semester, there are deliverables due each semester, and there is typically a high turnover in most groups. Thus, each semester teams effectively begin anew. In spite of these challenges, there is evidence that teamwork learning can be accomplished within a relatively brief, time-limited structure.¹⁸

There is a substantial body of research on team processes in various kinds of groups. Group process literature covers the gamut from temporary ad hoc teams assembled in a laboratory situation, to work teams, to the ongoing “teams” comprised of family members interacting over decades. Our teams are clearly near the short-term, semi-structured end of such a dimension.

Generally, the consensus is that a period of getting acquainted and building trust must precede the ability to work effectively together. The challenges of doing this are insightfully described by Galvin, McKinney, and Chudoba.¹⁹ They noted the importance of the “psychological contract” in team formation, where individuals implicitly – or explicitly – agree to trust each other to respond in predictable ways. From this we expect that IPRO teams who have pre-existing “psychological contracts” may have an advantage in team formation. However, we have observed that many of our teams did not start to perform – work together effectively – for 4-5 weeks, which significantly reduces the time available for actual problem solving.

Our strategy now is to identify ways of speeding up the process of team formation and team building, so that teams can get to the performing capability more rapidly. This is a report on our first systematic effort to evaluate the success of a “game-based” intervention.

2. Method for “Games” Intervention Research

2.1 Measures of Teamwork Functioning

Students are asked to complete an Informed Consent statement before measures of perceived accomplishments and team functioning are collected; they are informed that these scores are being used for research purposes, to improve the overall quality of the program; and are informed that their performance will not be used as part of their IPRO grade.

We are using multiple measures of team functioning, in hopes of learning more about the processes occurring within our undergraduate teams, and to assess the impact of our intervention attempts. Thus, we have student perceptions of the functioning of their team, of their own knowledge about teamwork generally, and of their competence in terms of teamwork skills. We are also employing team-level measures of functioning, such as their ability to produce and revise good project plans, and their performance at IPRO Day. These measures are summarized below.

Team Excellence and Trust Survey: This measure includes 20 statements designed to tap the extent to which each team member feels that his/her team is characterized by the qualities associated with high-functioning teams, and that indicate high levels of trust and mutual respect. Students are asked to whether each statement can be answered by True, More True Than False, Neutral, More False Than True, or False. Ten of the items are drawn from a measure developed by St. Aubin, Haggerty Associates, Inc.¹⁴ on the basis of research reported by LaFasto & Larson for team excellence.¹⁵ We have been using a version of this survey to assess teamwork functioning in the IPRO teams over the past three years. The items have high face validity based

upon the assessment of the IPRO research team; construct validity was established for industry work teams on the basis of the LaFasto & Larson research. Construct validity has not been established for undergraduate semester-long teams. Another ten items assess trust among team members, drawn from an instrument developed by De Hoyos and Resta²⁰ for use with college graduate students taking an online course in teamwork. They randomly assigned or allowed 512 students to self-select into teams; the measure includes items tapping task management, positive social interaction, and trust. In our measure we have selected items dealing with trust. It is appealing because it has reliability and validity data and has been used with undergraduate groups working in project teams;^{21 18} (De Hoyos Guevara, 2004); however, it has not been widely used, and does not have normative data. For the first semester data, this survey had high internal consistency (Chronbach's alpha = .87). This 20-item survey was administered during the 5th week of the semester (after teams have had some opportunity for forming), and again at the end of the semester. The statements included in this measure are shown in Figure 1.

Figure 1

Fall 2006 Team Excellence and Trust Survey

Directions: Describe your Team according to the items below. Indicate whether you think the statement is True (5), More True than False (4), Neutral (3), More False than True (2), or False.

1. There is a clearly defined need that justifies the existence of our Team.
 2. Each member's relationship to the Team is defined in terms of role clarity and accountability.
 3. We have an established method for monitoring individual performance and providing feedback.
 4. Team members possess the essential skills and abilities to accomplish the team's objectives.
 5. Achieving our team goal is a higher priority than any individual objective.
 6. Team members are willing to devote whatever effort is necessary to achieve Team success.
 7. We help each other by compensating for individual shortcomings.
 8. As a Team, we embrace a common set of guiding values.
 9. Our Team has high standards of excellence.
 10. Our Team exerts pressure on itself to improve performance.
 11. Students on this team keep agreements; if they cannot they renegotiate those agreements.
 12. Students on this team would not deceive one another for personal gain.
 13. Students on this team would not accept credit for another student's work they did not perform.
 14. Students communicate openly and honestly in their interactions with each other.
 15. Students talk through problems with those they feel have wronged them in some way.
 16. Students keep appropriate information confidential; they would not betray a confidence for personal gain.
 17. Students on this team openly admit and take responsibility for the mistakes they have made.
 18. Students are willing to give and receive constructive feedback from each other without getting defensive.
 19. Students on this team are open to considering new ideas or trying new methods.
 20. Students seek the input of their peers in attempting to solve problems.
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Cognitive/ Declarative Knowledge about Teamwork: We have developed a body of knowledge and question banks designed to tap familiarity with key constructs in each of the four learning objective areas. Students are provided with study materials, questions and answers on the web. A pre-test is administered during the first week, and a post-test during the fifth week. One of the test versions is included below, with the answer key; see Figure 2.

Figure 2: Knowledge Test Questions on Teamwork

1. A(n) _____ is a small group of people with complementary skills, who work actively together to achieve a common purpose for which they hold themselves collectively accountable.
- A. Contingent
 - B. Cohort
 - C. Team
 - D. Assemblage

Answer: C

2. _____ are established to study specific problems and recommend solutions to them.
- A. Teams that run things
 - B. Teams that recommend things
 - C. Teams that study things
 - D. Teams that make or do things

Answer: B

3. A high-performing team can be created by doing the all of the following EXCEPT:
- A. Communicating high-performance standards
 - B. Having members spend time together
 - C. Creating a sense of urgency
 - D. Ensuring that new information is kept to a minimum

Answer: D

4. _____ doesn't always happen naturally in a group; it is something that team members and leaders must work hard to achieve.
- A. Environmental analysis
 - B. Performance appraisal
 - C. Teamwork
 - D. Strategy formulation

Answer: C

5. Which of the following accurately describes the sequence of steps in the team-building process?
- A. Establishing a team mission statement; team goal setting; data gathering and analysis; implementing team goals; and evaluation of results
 - B. Planning for team effectiveness; data gathering and analysis; establishment of team goals and objectives; implementing team goals; and evaluation of results
 - C. Establishing a team mission statement; team cohesiveness training; data gathering and analysis; actions to improve team functioning; and implementing team goals
 - D. Problems or opportunities in team effectiveness; data gathering and analysis; planning for team improvements; actions to improve team functioning; and evaluation of results

Answer: D

6. *The third step in the team-building process occurs when _____.*
- A. Members work together in taking actions to improve team functioning.
 - B. Members work together in evaluation of results.
 - C. Members work together in planning for team improvements.
 - D. Someone notices a problem or an opportunity in team effectiveness.

Answer: C

7. *Which of the following statements is NOT an accurate description of team building or the team-building process?*
- A. Team building is participatory
 - B. Team building is data based
 - C. The team-building process should become an ongoing part of any team's work agenda
 - D. The team-building process facilitates competitive behavior within the team

Answer: D

8. *In a(n) _____ to team building, the manager, team leader, or group members themselves take responsibility for regularly engaging in the team-building process.*
- A. Formal retreat approach
 - B. Employee participation approach
 - C. Outdoor experience approach
 - D. Continuous improvement approach

Answer: D

9. *To improve team processes, both team leaders and members must be prepared to deal positively with all of the following EXCEPT:*
- A. Introducing new members
 - B. Handling disagreements on goals and responsibilities
 - C. Handling reward distribution issues
 - D. Resolving delays and disputes when making decisions

Answer: C

10. _____ directly contribute to the performance of important group tasks.
- A. Task activities
 - B. Assignment mandates
 - C. Directive activities
 - D. Responsibility activities

Answer: A

11. A _____ is a set of expectations associated with a job position on a team.

- A. Perceptual set
- B. Positive norm
- C. Position characterization
- D. Role

Answer: D

12. *The process through which individuals negotiate to clarify the role expectations that team members have for one another is known as _____.*
- A. Role arbitration.
 - B. Role negotiation.
 - C. Role bargaining.
 - D. Role intervention.

Answer: B

13. _____ are rules or standards for the behavior of group members.

- A. Norms
- B. Roles
- C. Routines
- D. Conventions

Answer: A

14. Group or team cohesiveness tends to be high when all of the following conditions are present EXCEPT:

- A. When the group experiences performance success or crisis.
- B. When members respect one another's competencies.
- C. When members agree on common goals.
- D. When all members are similar in age and attitudes.

Answer: A

15. _____ are small groups empowered to make the decisions needed to manage themselves on a day-to-day basis.

- A. Self-sanctioned teams
- B. Virtual teams
- C. Egocentric teams
- D. Self-managing teams

Answer: D

Self-perceived Teamwork Competencies: We have developed a 30-item survey to assess the extent to which each student feels they have mastered the meta-learning objectives; a subset of these items tap perceptions of competence in teamwork. These surveys, also on a 5-level scale, are administered at the end of the semester. The items tapping teamwork competencies are listed below. Students answered each one on a 5 point scale (agree strongly, agree, neutral, disagree, disagree strongly).

Figure 3. Self Assessment of Teamwork Competencies

<p>Learning Objective: Teamwork is a sense of collective accountability with team members who actively work together in a way that all their respective skills are well utilized to achieve a common purpose</p> <p>Please answer the following nine questions with the above definition in mind.</p>
11. I modified my individual goals to fit with the team goals.
12. I did not encourage team members to recognize the contributions of each person.
13. The process of decision making adopted by my team was clear to me.

14. I was aware of the team ground rules and I adhered to them.
15. I took part in team processes and felt a sense of personal responsibility for the team outcomes.
16. My team members say that I do not regularly attended team meetings.
17. My team members say that I was prepared for team meetings.
18. I encouraged my team members to identify alternative solutions when making decisions.
19. I shared equal responsibility for team decisions.

Team Project Plan: Each team is required to submit a project plan by week 5 of the semester. These have been graded using a standardized rubric.

Team Midterm Report: Each team is required to submit a Midterm report, including modifications to the initial plans. These have been graded using a standardized rubric.

I PRO Day Judging Scores: During the last week of the semester all teams prepare oral presentations and exhibits demonstrating their work. Each team is evaluated by an average of seven judges (drawn from faculty, alumni, project sponsors, etc.) on the basis of structured rating forms that provide scores for teamwork, project management, communication, and ethical awareness. For these analyses we will use judges' scores for the teamwork dimensions, as displayed both in presentations and exhibits. The judging forms for exhibits and presentations are shown below in Figures 4 and 5.

Figure 4. I PRO Day Judges Exhibit Evaluation Form

Fall 2006 I PRO Projects Day Conference

I PRO/EnPRO Project Exhibit Evaluation Form

The learning objectives of the IIT Interprofessional Projects (I PRO) Program include multi-disciplinary teamwork, communication, project management and ethical behavior. While we appreciate that the projects vary widely in content and in their stage of development, all I PRO projects should attempt to achieve these objectives. We wish to recognize the teams that have achieved notable distinction in meeting these objectives. We welcome any additional comments, which will be shared with the I PRO faculty.

3 I PRO/EnPRO Project Number/Title: _____ / _____

Name of Judge: _____

Please rate each criterion on a scale of 1 – 10, 1 being very low and 10 being very high. Add up the points for each subsection and confer with your co-judges for consistency.

I. Teamwork, Communications and Ethics *Rate from 1-10*

- _____ The exhibit material/activity focuses on a well-defined and easy to grasp problem definition.
- _____ Additional exhibit activities, demonstrations, graphics, props, handouts and visuals are used effectively and communicate the project objectives and project results.
- _____ Ethical problems of the team were recognized and addressed appropriately.
- _____ **The Project Abstract is well organized, available and used in the discussion at the exhibit.**

Teamwork, Communications and Ethics total score: _____/40

II. Project Management *Rate from 1-10*

- _____ The team prepared, revised and used a project plan to guide their activities during the semester.
- _____ The team defined roles and assigned tasks regularly to team members and tracked work progress.
- _____ Several different team members are able to explain the objectives, plans, and project problems, results of the semester project and the next steps.
- _____ The team actively monitored and controlled team activities throughout the semester.

Project Management total score: _____/40

III. Overall Project Evaluation *Rate from 1-10*

- _____ Final Project Team Report exists and is complete, Final Team CDROM exists[see TOC] and all team CDROM contents are entered into iKNOW. Team has produced all required IPRO deliverables and received the **IPRO Deliverables Completion Certificate** from the IPRO Office. Team used iGROUPS consistently throughout the semester to support team communications and the work of the team.
- _____ Overall, the project is well led and managed, creative work has been done, substantial progress was made on problem resolution and results presented are clearly an effort of the whole team.

Overall Project Evaluation total score: _____/20

TOTAL SCORE: _____/100

IV. **Other observations/comments**

Figure 5. IPRO Day Presentation Judging Forms

Fall 2006 IPRO Projects Day Conference

IPRO Project Presentation Evaluation Form

The learning objectives of the IIT Interprofessional Projects (IPRO) Program include multi-disciplinary teamwork, communication, project management, and ethical behavior. While we appreciate that the projects vary widely in content and in their stage of development, all IPRO projects should attempt to achieve these objectives. We wish to recognize the teams that have achieved notable distinction in meeting these objectives. We welcome any additional comments, which will be shared with the IPRO faculty.

IPRO Project Number/Title: _____/_____

Name of Judge: _____

Please rate each criterion on a scale of 1 – 10, 1 being very low and 10 being very high. Add up the points for each subsection and confer with your co-judges for consistency.

I. Teamwork, Communications and Ethics Rate from 1-10

- ___ Presents the problem and results in an organized manner.
- ___ The presentation and question and answer session is shared among several team members
- ___ Uses visual aids/props and manages allotted time effectively.
- ___ The team recognized and addressed ethical issues encountered during the project.

Teamwork, Communications and Ethics total score: _____/40

II. Project Management Rate from 1-10

- ___ The team prepared a project plan which guided their activities during the semester.
- ___ The team defined roles and assigned tasks regularly to team members.
- ___ The team adequately utilized all team members and the available faculty/sponsor resources.
- ___ The team actively monitored and controlled team activities throughout the semester.

Project Management total score: _____/40

III. Overall Project Evaluation Rate from 1-10

- ___ The team results met the team's original objectives.
- ___ Overall, the project is well led and managed, creative work has been done, and substantial progress was made on problem resolution and the results presented are clearly an effort of the whole team.

Overall Project Evaluation total score: _____/20

TOTAL SCORE: ___/100

2.2 The IPRO Games Intervention

Over a period of two semesters, one of the IPRO teams dedicated to improving the processes of the IPRO program explored a variety of exercises and games designed to promote teambuilding. They met with a consultant specializing in the use of such tools, and tried out various possible games for their suitability in the IPRO program. Their criteria included feasibility (e.g. no wilderness walks), complexity (challenging enough to be fun but not so difficult that participants simply got discouraged), feasible financial and labor demands (for directing/supervising the operations, materials needed, food), multi-cultural acceptability (e.g., no touching), and safety (no blind-folding or games that physically challenged students could not participate in). They pilot-tested a set of games during the spring and summer sessions of 2006, and then recommended a set of five games to use at the start of the fall semester.

The IPRO Games were offered to all teams, with encouragement to attend as a team. We recognize that the ideal assessment protocol would be to randomly assign teams to attend the IPRO Games or not, but that design is not politically feasible at this time.

The event took place on the Saturday afternoon after the semester had started on Thursday; unfortunately, not all the IPRO teams had met prior to the Games. Students were encouraged to attend with members of their teams; however, students who came as the only one or two from their team were put together to form ad hoc teams. Games began at 1:30, and ended at 5:30 with a special barbeque buffet and allocation of prizes (which included iPods for all team members on the top-scoring team, baseball tickets, etc.).

The five games selected were Bull Ring, Tower of Terror, Helium Pole, Zin Obelisk and Scavenger Hunt (instructions and scoring sheets are available from the authors). For example, in *Helium Pole* the object of the game is to lower a long metal pole from four feet to the ground using a systematic team effort. Team members are arranged in two rows facing each other equally spaced apart, and are asked to support the horizontal pole on their extended forefingers. All team members must be touching the pole with their fingers at all times during the lowering. In *Tower of Terror* the goal of the game is to build a structure out of raw spaghetti and miniature marshmallows sturdy enough to support the weight of a hard-boiled egg. The highest structure that can hold up an egg for at least three minutes wins the game.

Each game requires team members to interact positively to meet the objectives. At the beginning of each game period a facilitator explains the game objective and rules, informing them that the team has 5 minutes to plan, 30 minutes to play the game, and 5 minutes to debrief. The facilitator observes intra-team interactions closely. During the debriefing, the facilitator initiates discussion by asking questions such as: What role did each team member play? What was your team's strategy? What made your team effective? How could you have been more effective? How did communication and teamwork play a role in your success? What teamwork skills were necessary for success? How can these skills be beneficial to you in the future? What skills used by your team can be applied to other teams or work environments? Why is non-participation so difficult to overcome in teams? How did your strategy change as the level (of difficulty) progressed? (A subset of these was asked in each game.) The facilitator evaluated the team performance on planning, execution, and debriefing, with a total possible score of 40.

All teams also participated in *IPRO Idol*, with a challenge to “write and choreograph a two-minute song about your team, teamwork and the IPRO Games”; these were presented during the final segment of the day, and were evaluated by the facilitators as a group. The teams were encouraged to work on their productions throughout the afternoon during breaks or other lulls in programming, and most did so.

All games took place in a central conference facility on campus, with a separate space for each game. Each team played three of the five games, during the time slots allocated for games.

Personnel used to conduct the Games included two undergraduate student employees who assembled packets and materials, and coordinated the overall games processes, and a facilitator for each game. Each facilitator did three rounds, with different teams. Facilitators were recruited from faculty and graduate students, and were trained the day before the games during a two-hour session. The graduate students were modestly compensated (\$50) for their time.

2.3 Population and Sample

The population for this report includes the 29 IPRO and 6 ENPRO teams active during the fall 2006 semester. This includes approximately 400 students, most of them juniors and seniors. The final sample, for whom we have data on the measures, includes 53 students (17.6%) who indicated they participated in the IPRO Games and 248 students who said they did not participate.

Demographic, prior experience, and expectation characteristics of the students who provided data are shown in Table 1; these are characteristics the students bring with them into the IPRO team experience that may influence team functioning.

Table 1. Sample Characteristics

Characteristic	Results
Year in school	Sophomore or below: 4.0%
	Junior 33.2
	Senior 41.5
	Fifth year UG 17.6
	Graduate 3.7
Gender	Male 69.1
Country of residence	USA 68.3
Primary major	Architecture 14.5
	Science & Letters 36.3
	Engineering 45.9
	Psychology 3.3
Cumulative GPA (4.0 top)	Mean (S.D.) 3.27 (.39)
Number of prior IPRO projects	None 50.9
Continuing with same IPRO?	Yes 20.4
Ever participated in any leadership training courses?	Yes 41.0
Have you or do you hold a leadership position?	Yes 59.1
Have you taken organizational behavior class?	Yes 34.4
Did you know any team members before IPRO?	Yes 71.7
Have you worked on a project with any of your teammates before this IPRO?	Yes 34.3

How well did you know other team members prior to project?	Very well	2.9
	Pretty well	7.2
	Mixed; knew some	29.0
	Slightly	34.1
	Not at all	26.8
In the beginning, how did you feel about this project?	Positive	38.0
	Somewhat positive	39.9
	Neutral	19.2
	Somewhat negative	1.4
	Negative	1.4

3. Analyses and Results

3.1 The first set of analyses was carried out at the *individual level*, comparing responses of students who reported that they did attend the IPRO Games and those who said they did not. The test variables includes a set of variables which, based on our review of the research, may affect teamwork functioning in IPRO teams. T-tests for independent groups were used to compare these two groups of students. This information is essential in order to evaluate the impact of the Games intervention; if the groups differ on crucial characteristics before this experience it is unlikely we can demonstrate any clear effects. Because of the complexity of factors known to contribute to teamwork functioning, we decided to look for significant differences ($p < .05$) and trends ($p < .10$).

There were no systematic differences between these groups of students in terms of gender, year in school, citizenship, number of IPROs, participation in formal leadership training courses or experiences prior to the IPRO, or being or have been a leader or supervisor prior to the IPRO.

The students who participated in the games showed a wider variation in prior familiarity with team members than those who did not attend the games. However when this variance is taken into account, the participants and non-participants did not differ overall in the likelihood that they knew or had worked with the students who became their teammates for this semester. However, there were trends toward participants having a higher overall GPA, and being new to that IPRO. The most marked difference was in the initial set of expectations about the IPRO, as recalled and reported at the end of the semester. Students who reported feeling more positive initially about their project were significantly more likely to attend the IPRO Games

As hoped, there was a trend for students who participated in the IPRO Games to feel more positive about their team functioning at week 5. However, by the end of the semester most of the students felt positively about their team functioning and there were no differences between those who did or did not attend the games; means for both groups were 4.3.

There were no differences between students who attended or did not attend the games in terms of their performance on the cognitive/declarative knowledge tests of the learning objectives or on their self-assessed competence in the learning objectives at the end of the semester.

3.2 For the second set of analyses we compared two groups of *teams*: those who sent at least one team member to the IPRO Games ($n = 14$), and those who did not ($n = 20$). The number of teams participating was too small to make finer distinctions in terms of the number of participants from each team. At the team level of analysis we can compare team level measures

of team functioning. In terms of the management products rated, there was a trend that teams where at least one member attended the games were more likely to submit good initial project plans ; they were significantly more likely to submit a good Midterm Report dealing with modifications to the initial plans. There were no statistically significant or trend differences between the groups of teams on IPRO day performance.

4. Discussion

This inquiry is the first step in providing an empirical assessment of a type of tool that has been widely used in work settings to enhance and speed-up the process of team formation. Many undergraduate programs have moved quite determinedly to offering experiences in project teamwork, in response to requirements like those set forth by ABET and in response to the recognition that the competencies needed to work effectively in multi-professional/multi-disciplinary teams are highly valued by employers. While the goals are by now quite clear, the strategies needed to reach those goals are not.

The first trial was an excellent learning experience for us. On the basis of our experience (even before receiving the results), we decided that some changes are crucial. First, the Games intervention should occur during the first weekend but after all the teams have met; this should improve participation, particularly in terms of having a majority of team members present for the event. It is (presumably) not the same experience to go through the exercises as a member of a team assembled for the afternoon as it is to participate with the students who will be on your team for the semester. We are not trying to improve abstract teamwork sensitivities, but help the actual teams consolidate more rapidly; thus, it is considered essential to have a critical number of members present (whatever that number is). We are making more efforts to involve more members of teams; realistically we know it is unlikely that we will have complete teams involved in the games.

If the collective games experience does not prove to be effective, or feasible, we may move toward having each team do similar team-building games as part of their start-up. While a few of the faculty leaders currently include such activities, most do not. We could, presumably, guide the faculty toward this model.

Anecdotally, we know that some teams are composed of several students who in effect have already formed a team; often they elect to join the same IPRO so they can continue working (and playing) together. The challenge for those teams is to learn how to incorporate “others” who join the team. Some teams are composed of students from different majors and with no prior acquaintance; we have heard that some of these teams consolidated rapidly on the basis of their IPRO games experience. However, the variability is such that the impact does not show up clearly in group analyses.

It is interesting to note the characteristics associated with individuals attending the IPRO games. The clearest predictor is the initial enthusiasm for the IPRO project; a secondary one is higher GPA. It may be that these drive some of the other correlates: students who are better generally at mastering the academic system (shown in GPA), and who are enthusiastic about what they are embarking on, are able to feel most positively about their team functioning early on, and to help their team produce better “products” such as the Midterm Report; they may, in fact, have been largely responsible for such products. The importance of initial predispositions is not a novel finding, of course. The challenge for educators mounting a program where all students are required to participate, regardless of initial enthusiasm, is to find ways of engaging those reluctant students – or at least to help their teammates work with (or around) them.

We believe that the IPRO Program is offering many of the ingredients of a successful learning experience; combining work on a meaningful project, cognitive knowledge, opportunities for performance, timely and relevant feedback, and incentives for learning. However, we cannot yet clearly demonstrate the impact of any of the strategies utilized on the attainment of learning objectives. We are continuing the analyses, and will augment the data gleaned from our first trial semester with this intervention with that from subsequent semesters. Ultimately, we anticipate doing multi-university evaluations to identify best practices based on good evidence. At this time, this particular intervention is promising enough to warrant continued evaluation.

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