

# Assessing Team Development in an Engineering Project-Based Course

Chad E. Davis

Electrical and Computer Engineering  
University of Oklahoma  
Norman, OK, USA

Kim Graves Wolfenbarger

Gallogly College of Engineering  
University of Oklahoma  
Norman, OK, USA

**Abstract**—This Innovative Practice full paper discusses the use of a newly created Teamwork Evaluation Worksheet in an undergraduate professional development course for engineering and applied science students. This course covers topics not typically taught in other engineering courses, including leadership, teamwork, ethics, project management, technical writing, public speaking, and entrepreneurship. Students work in groups to complete a series of projects, each emphasizing a different skillset or theme. In the past, students have switched groups for each of the four projects, and almost every student has had the chance to serve as “team leader” for one project. This was intended to give students more diverse teamwork and leadership experiences. Although the structure provided some benefits, fostering good teamwork skills was not among them, in part because the students were not able to stay together long enough for their teams to develop effective teamwork practices.

To address this issue, we redesigned the course so that the students remained in the same group for the first two projects, and then switched to two different groups for the final two projects. To accompany this change, principles of effective teamwork based on a shared leadership philosophy were taught to the students at the beginning of the semester so they could apply them in their group. The goals of the new leadership course content and the Team Evaluation Worksheet were to facilitate effective teamwork processes, to encourage the exercise of shared leadership within project teams, and to allow team members a non-punitive evaluation method that could be used to make adjustments. This paper shows how this leadership content was integrated into an engineering project-based course and how the Team Evaluation Worksheet was used to help the students improve the effectiveness of their team.

**Keywords**—professional development; team-based learning; multidisciplinary teams; shared leadership; team evaluation

## I. INTRODUCTION

At the University of Oklahoma, most engineering students take a course titled ENGR 2002: Professional Development. This course was developed in 2012 to provide a unique multidisciplinary team experience [1]. In addition to giving the students an opportunity to become more proficient in working on a multidisciplinary team, the course covers many non-technical topics that are important for engineering students and for ABET accreditation, including the following:

- Leadership
- Fundamentals of conducting research
- Technical writing
- Project management
- Public speaking and presentation creation
- Ethics
- Idea Protection
- Technical Ideation
- Entrepreneurship

Students learn about these topics through four team projects: Greatest Achievements of the 21<sup>st</sup> Century, Experimental Validation of a Scientific Principle, Ethical Disasters, and the Great Idea. For each project, teams create a presentation and conduct a collaborative writing assignment. As peer learning is a major curriculum design element of this course, classmates serve as judges for each of the four project presentations.

For Project 1, *Greatest Achievements of the 21st Century*, teams provide an overview of two engineering achievements and describe how they were developed and brought to market. They also consider the global context of these achievements by exploring both societal benefits and unintended consequences. They create a logical criterion and justify which of the two candidates should be considered the greatest achievement of the 21st century. Deliverables for this project include a PowerPoint-style presentation and a technical abstract.

Project 2 requires the students to design an experiment to validate a scientific principle. They also choose a product or application that relies on the selected principle. For example, in a previous semester a team created an experiment to validate the Ideal Gas Law ( $PV = nRT$ ) and selected the automobile air bag as the application. Instead of a PowerPoint-style presentation, the students create a video to document their experiment and explain the application. For the writing assignment, the groups act as if they were the engineering team who first proposed the idea of applying this scientific principle to the product or activity (e.g. the air bag) and write a white paper soliciting funds from an audience of potential investors.

For Project 3, *Ethical Disasters*, each group performs a thorough literature review to identify two engineering disasters, one of which must have occurred within the last ten years. The groups discuss the ethical and criminal issues related to the disaster and the societal, economic, and political impacts that resulted. They also analyze the key reasons for unethical conduct and connect the ethical failures to specific sections in the NSPE Code of Ethics. A PowerPoint-style group presentation is delivered to the class and an IEEE-formatted paper detailing one of the ethical disasters is completed.

Project 4, *The Great Idea*, ties together many of the topics learned in the first three projects and adds business and entrepreneurship concepts [2, 3]. Each student individually identifies a market problem, develops a solution, and writes a descriptive abstract. The entire class votes for their favorite idea. The abstracts with the most votes are identified, and groups are formed based on the idea preferences of the students. The students create both an elevator pitch video and a PowerPoint-style presentation for this project, as well as a written business plan explaining how the idea will be developed into a product and brought to market.

## II. BACKGROUND

College students are generally familiar with hierarchical leadership structures. According to the Leadership Identity Development Model [4, 5], the typical student begins college with a “leader-identified” view, where leadership is tied closely to a person’s position in a group, and where group members without a leadership position are by definition followers. Hierarchical structures are seen as the norm. As students progress through college, their view often expands. Through participation in groups, they may come to appreciate the notion that a group member can be “a leader” without being “the leader,” and that an effective group may have many leaders providing expertise, skill, and influence as appropriate. As a student’s leadership identity matures, their view shifts from leadership as a positional phenomenon to leadership as a process, which encourages broader participation among group members.

Because engineering design is often a collaborative process, it is important for students to understand the group structures that facilitate collaboration. A hierarchical model, where decision-making is dominated by a small group of positional leaders, may stifle idea generation, critical discussions, and creativity. A more flexible structure, on the other hand, may allow groups to incorporate more voices and produce better, more creative solutions.

To encourage this collaborative mindset, we introduced students to the shared leadership framework. As defined by Pearce and Conger [6], “Shared leadership is a dynamic, interactive influence process among individuals in groups for which the objective is to lead one another to the achievement of group or organizational goals or both.” Put more bluntly by Google’s Laszlo Bock, “What we care about is, when faced with a problem, do you, at the appropriate time, step in and lead? And just as critically, do you step back and stop leading,

do you let someone else? Because what’s critical to be an effective leader in this environment is you have to be willing to relinquish power” [7].

In a shared leadership framework, roles and responsibilities may be assigned, but the notion of rank is absent. Instead, all team members work together to set goals, define work processes, and establish norms. Each team member helps to provide input, track progress, monitor performance, and provide assistance to other team members as needed. For a shared leadership framework to be effective, team members should exhibit a “team orientation” [8]. When making decisions, team members should consider the team’s goals to be above their own, and they should solicit other team members’ perspectives when considering a course of action.

Although conventional wisdom holds that every team must have a positional leader, research has shown shared leadership and similar decentralized structures to be effective. In a study of 3-person student teams in an MBA course, for example, Carson and colleagues found that shared leadership contributed to better project outcomes, as measured by client satisfaction [9]. Pearce and Sims [10] found that while both hierarchical and shared leadership structures within change management teams could produce positive outcomes, shared leadership was more strongly associated with team effectiveness. Shared leadership and similar structures are particularly helpful when the work is complex [11] and in fast-moving, high-stakes environments such as medical trauma centers [12]. Shared leadership can facilitate inclusion by encouraging the full participation of team members from non-dominant groups [13]. Furthermore, learning how to work within a structure where leadership is shared can enhance engineering graduates’ ability to work successfully in modern companies, such as W. L. Gore and Associates [14], Semco of Brazil [15], and Google [7].

What are the necessary precursors to shared leadership? When students have been conditioned to expect and respond to hierarchical structures, how can shared leadership be encouraged? First, the members of the team must be willing to contribute to team leadership. As Laszlo Bock noted [7], they need to know when to step in and when to step back. Furthermore, team members must have the right attitude. Carson et al. [9] found that a positive internal team environment contributed to the development of shared leadership. When members believe that the team has a shared purpose, provides social support, and allows everyone to have a voice, shared leadership is more likely to emerge. Reframing the definition of a leader may also be helpful. Students often see the leader as “the boss.” Understanding that everyone can contribute to leadership—that “a leader’s job is to do, or get done, whatever is not adequately handled for the group needs” [16]—can help students internalize a leader identity and take a more active role in advancing a project’s progress [5].

Of course, the leadership structure is not the only factor contributing to team success. A clear purpose and a supportive organizational context are also essential elements [17]. Team effectiveness is further enhanced when the structure is results-driven, team members possess technical competence, the team adopts a standard of excellence, and team members cultivate a

collaborative climate [18]. And the team members themselves should possess a learning orientation [18] and exercise effective teamwork behaviors, such as mutual performance monitoring, backup behavior, and adaptability [8].

### III. METHODOLOGY

In the Professional Development course, students are divided into groups of four or five people each. Almost every student has the opportunity to serve as the designated “team leader” for one of the four projects. In the first four years of the course, from 2012 to 2016, project groups were shuffled for each of the group projects and a different team leader was selected for each group. This structure was created to give students more diverse teamwork and leadership experiences. Although the structure provided some benefits, fostering good teamwork skills was not among them. The students were not able to stay together long enough for their teams to develop effective teamwork practices, and teamwork skills were not a focus of the course.

The philosophy emphasized during this period was focused on a top-down, individualistic style of leadership. In 2016, the course was redesigned to teach a shared leadership philosophy as discussed in the previous section. As a result, the structure of the project groups was changed. Since the shared leadership model teaches that everyone in the group should exercise leadership behaviors, the “team leader” title was changed to “project manager.” The group reshuffling procedure was modified so that the students remained in the same group for the first 2 projects (roughly half of the 16-week semester), and then switched to a different group with all new team members for project 3. The Project 4 groups were also new and set based on the Great Idea voting algorithm, as described in Section I.

The goals of the course change were to facilitate effective teamwork processes, to encourage the exercise of shared leadership within project teams, and to allow team members a non-punitive evaluation method that could be used to make adjustments. Principles of effective teamwork were taught to the students at the beginning of the semester so they could apply them in their groups. The Team Evaluation Worksheet (discussed in detail in Section IV) was created to help them develop as a team.

College students are often resistant to teamwork. Previous experience has taught them that teams are often dysfunctional, that social loafers benefit at the expense of conscientious students, and that high-performing individuals can often produce better results alone than within a team. As faculty, we know that many team problems occur because students are not taught about teamwork, but are expected to learn it “on the job.” The content presented in this course module provides a scaffold on which students can build a structure for effective teamwork.

To introduce students to these concepts of shared leadership and effective teamwork, we created a new two-lecture module. The first lesson covered effective teamwork behaviors [20, 8], characteristics of effective teams [17, 18, 21], and promoting a

positive team climate [9]. The concept of shared leadership [6] was introduced in the second lecture.

In the first lecture, we presented the characteristics of effective teams as enumerated by Hackman [17] and LaFasto and Larson [18]: Effective teams have a clear and elevating goal; an enabling, results-driven structure; the right people; a collaborative climate; and standards of excellence. Some of these elements are easier to achieve than others. For example, in this course the goals of the projects are already clear, because they are defined within the assignment. Establishing an “elevating” goal, one that the team members believe to be worthwhile and important, may be more difficult. We encouraged students to think about ways to elevate the goals of the course projects beyond “Make an A” or “Make a passing grade,” and thereby enhance participation and commitment.

An appropriate structure is necessary for effective teams in any setting, regardless of the leadership style. Whether the leadership is centralized and hierarchical or decentralized and shared, establishing the structure is a function of leadership [22]. We encouraged students to establish roles and set clear expectations regarding action items, responsible personnel, the schedule, and communication processes. All teams were required to designate a Project Manager. We strongly encouraged teams to also designate a Team Climate Monitor, a person responsible for making sure that all group members were heard in discussions and were fully included in the work. Other roles could be determined by the teams as they saw fit.

Personnel selection is often a challenge on team projects. In this course, students do not choose their team members. Instead of finding the right people, they must identify the knowledge, skills, and capabilities of each team member and match those attributes to team roles. Each member must be willing to develop their technical competence, engage in critical thinking, exercise good interpersonal skills, take action, exhibit a positive attitude, and possess a team orientation.

Creating innovative solutions is facilitated when the team environment is collaborative. On a collaborative team, members listen to each other, encourage the free flow of ideas, and work together to solve problems. We encouraged the students to coordinate team members’ efforts instead of relying on the common practice of dividing the tasks into individual parts and mashing the results together just before the due date.

We also stressed the importance of trust. Before a team can truly collaborate, the members must trust each other. Each person should be open, honest, consistent, and respectful. People speak plainly while also considering the feelings of others. They do what they say they will do, they arrive on time to meetings, and they produce quality work. By behaving in a trustworthy and respectful fashion, members lay the foundation for successful teamwork.

Finally, an effective team must have standards of excellence. They must set clear expectations for results; review the results early and often, providing constructive feedback; and reward results by acknowledging team members’ contributions. In this

course, we acknowledge that the instructor sets the overall performance standard, but that does not absolve teams of this responsibility. Each team must decide *how* they are going to meet the instructor's standard, and they must set internal standards to meet that goal.

In the second lecture, we introduced the concept of shared leadership [6]. We compared and contrasted traditional, hierarchical notions of leadership with the modern, process-oriented view. We then taught the students how to use the team evaluation worksheet and connected the scale items to shared leadership concepts.

#### IV. TEAM EVALUATION WORKSHEET

The team evaluation worksheet is a team-level instrument that allows each member to assess the team as a whole, not the individual members. Unlike traditional peer evaluations, which are usually conducted at the end of the work period and thus have a punitive effect, this instrument is designed to identify potential problems while there is still time to correct them. To encourage mutual performance monitoring [8], we designed the team evaluation instrument to be used multiple times over the course of the work period.

Our questionnaire combines, with some modifications, two instruments previously developed by other researchers: The Teamwork Function Survey [23] (which draws on LaFasto and Larson's work [18]) and the Internal Team Environment Questionnaire [9]. Evaluation categories include Shared Purpose, Social Support, Voice, Results-Driven Structure, Technical Competence, Standards of Excellence, and Collaborative Climate.

In two of the categories, Technical Competence and Collaborative Climate, we created new questions to reflect the goals of the course. The Teamwork Function Survey [23] had only one question in the Technical Competence Question: "Team members possess the knowledge, skills, and abilities needed to accomplish the team's objectives." Because engineering students must sometimes learn the requisite skills for a project while working on the project, we thought it prudent to add a question regarding critical thinking: "Team members apply critical thinking skills when analyzing problems" (Question 15).

In the Collaborative Climate section, the Teamwork Function Survey asked only about "desire to contribute" and "sharing information, perceptions, and feedback." We have noticed two common problems with group projects: the tendency to choose a course of action quickly so that the group can get started with the "real work," and the inability or unwillingness of group members to ascertain and employ the skills of all members of the group. To address these problems, we added two questions to this section (Questions 18 and 21).

The responses to each of the 21 questions in the Team Evaluation Worksheet (shown below) are scored on a Likert scale ranging from 1 (strongly disagree) to 4 (strongly agree).  
*Shared Purpose*

- 1) The members of my team spent time discussing our team's purpose, goals, and expectations for the project.
- 2) The members of my team discuss our team's main tasks and objectives to ensure that we have a fair understanding.
- 3) The members of my team devise action plans and schedules that allow for meeting our team's goals.

##### *Social Support*

- 4) The members of my team talk enthusiastically about our team's progress.
- 5) The members of my team recognize each other's accomplishments and hard work.
- 6) The members of my team give encouragement to team members who seem frustrated.

##### *Voice*

- 7) People in this team are encouraged to speak up to test assumptions about issues under discussion.
- 8) As a member of this team, I have a real say in how this team carries out its work.
- 9) Everyone on this team has a chance to participate and provide input.
- 10) My team supports the active participation of everyone in decision making.

##### *Results-Driven Structure*

- 11) Team members understand their individual responsibilities.
- 12) We monitor each other's performance and provide constructive feedback.
- 13) Our decision-making process encourages judgments based on factual and objective criteria.

##### *Technical Competence*

- 14) Team members possess the knowledge, skills and abilities needed to accomplish the team's objectives.
- 15) Team members apply critical thinking skills when analyzing problems.

##### *Standards of Excellence*

- 16) Our team has high standards of excellence.
- 17) Our team exerts pressure on itself to improve performance.

##### *Collaborative Climate*

- 18) Team members generate multiple possible approaches before deciding on a course of action.
- 19) Each team member demonstrates a strong desire to contribute to the team's success.
- 20) We trust each other sufficiently to accurately share information, perceptions, and feedback.
- 21) The team effectively employs the unique skills and abilities of each team member.

At predetermined points during the process, each group member completes the survey. Scores are averaged to produce a team response rating for each item and for each category. Furthermore, individual responses are displayed so that the team can easily identify outliers. For example, if three members of a team give a positive rating for Question 9 but one student

gives a low score for the same question, the team should perform further enquiry to determine why one team member believes that not everyone has the opportunity to participate. Because the purpose of the worksheet is for the team to assess itself and for team members to openly discuss problems, the responses were not anonymous, and the assessment is not intended to be used to assign grades.

## V. RESULTS

During the fall and spring semesters of 2017 Team Evaluation Worksheet data for projects 1 and 2 were collected from 39 groups that each contained 4 to 5 students. These data (shown in Table I) were collected across several different sections of Professional Development taught by different instructors. Data were not used until the second semester that the study was in progress because the Fall 2016 semester was the pilot semester of the study and some processes were still being refined during that semester.

In order to improve the likelihood that the students in the study answered the questions conscientiously and honestly, groups in which one or more students gave the same response to all items (e.g. all 4's) were not included. In an attempt to get honest answers from the groups, the instructors did not coerce or influence the students to answer any particular way. Unfortunately, over half of the groups who completed the worksheet had at least one person who answered all 4's (the highest response) to all 21 questions for at least one of the two projects; those data were not included in our analysis. Even though less data was obtained due to the method in which the project was administered, the data that was obtained is more valuable because the students chose to use the tool instead of being tainted with untrue responses that came as a result of students rushing through it and answering all 4's.

Before exploring the data shown in Table I, it is important to note the differences between the two projects and how these differences could have affected the responses on the worksheet. In Project 1, the students learned about project management. They were required to create a Gantt chart and to clearly define individual roles within the team. In Project 2, the groups had the freedom to manage the group however they saw fit as long as they did not have the same Project Manager as Project 1. The focus of Project 1 on project management principles and the requirements included in Project 1 should have resulted in higher scores for the Shared Purpose category (Questions 1, 2, and 3). Table I supports this expectation with a 0.18-point drop from Project 1 to Project 2.

Another difference is that Project 2 was much more technical than Project 1 and required the special skill of video creation. Many of the students had no experience with video production or editing and had to learn these skills during the project. This lack of prerequisite knowledge should have resulted in a reduction in Project 2 scores for Question 14: "Team members possess the knowledge, skills and abilities needed to accomplish the team's objective." Table I supports this

expectation with a drop of 0.09 points from Project 1 to Project 2 for question 14.

Table I shows the average scores of the data collected for Projects 1 and 2 (labeled Pr. 1 and Pr. 2) in the fall and spring semesters of 2017. The Change column shows the average change in Likert-scale points from Project 1 to Project 2. The 2%↑ column shows the number of groups that increased by 2% or more between project 1 and 2. The 2%↓ column shows the number of groups that decreased by 2% or more.

TABLE I. TEAM EVALUATION WORKSHEET DATA FROM 39 GROUPS

Question/Category	Pr. 1	Pr. 2	Change	2%↑	2%↓
<b>Shared Purpose</b>	<b>3.79</b>	<b>3.61</b>	<b>-0.18</b>	<b>7</b>	<b>23</b>
Q1: Purpose	3.79	3.68	-0.11	5	15
Q2: Objective	3.79	3.74	-0.05	8	12
Q3: Action plans	3.76	3.41	-0.35	5	23
<b>Social Support</b>	<b>3.59</b>	<b>3.64</b>	<b>0.05</b>	<b>23</b>	<b>10</b>
Q4: Enthusiasm	3.46	3.56	0.10	22	11
Q5: Recognition	3.68	3.72	0.04	17	12
Q6: Encouragement	3.63	3.63	none	15	10
<b>Voice</b>	<b>3.82</b>	<b>3.79</b>	<b>-0.03</b>	<b>11</b>	<b>10</b>
Q7: Testing assumptions	3.70	3.77	0.07	13	8
Q8: I have a say	3.79	3.79	none	9	9
Q9: Participation	3.91	3.79	-0.12	6	12
Q10: Decision making	3.86	3.82	-0.04	10	11
<b>Results-Driven Structure</b>	<b>3.54</b>	<b>3.60</b>	<b>0.06</b>	<b>20</b>	<b>14</b>
Q11: Individual Responsibilities	3.67	3.60	-0.07	13	19
Q12: Performance monitoring	3.35	3.51	0.16	18	12
Q13: Decision-making process	3.61	3.69	0.08	14	17
<b>Technical Competence</b>	<b>3.81</b>	<b>3.78</b>	<b>-0.03</b>	<b>15</b>	<b>12</b>
Q14: Knowledge, skills, abilities	3.89	3.80	-0.09	7	11
Q15: Critical thinking	3.73	3.76	0.03	16	12
<b>Standards of Excellence</b>	<b>3.43</b>	<b>3.46</b>	<b>0.03</b>	<b>18</b>	<b>16</b>
Q16: High standards	3.55	3.47	-0.08	12	16
Q17: Performance improvement	3.30	3.45	0.15	20	9
<b>Collaborative Climate</b>	<b>3.64</b>	<b>3.65</b>	<b>0.01</b>	<b>16</b>	<b>13</b>
Q18: Solution generation	3.47	3.48	0.01	15	19
Q19: Team orientation	3.69	3.50	-0.19	7	17
Q20: Trust	3.77	3.81	0.04	16	9
Q21: Unique skills	3.61	3.81	0.20	19	7

Overall scores on all questions at both administration times were positive, averaging 3.30 points or higher. However, the scores did not change much between the two projects. When positive changes occurred, the magnitude tended to be very small (0.05 points or less). No scores increased by more than 0.20 points, and the average scores of close to half of the 21 questions were lower following Project 2.

Some of the decrease in scores could be attributed to a common phenomenon with pre-post tests: On any pre-post measure of this type, we expect some scores to be lower on the post-test due to students' increased knowledge about a number of items, including their teammates' working styles, course material, instructor's expectations, and team performance.

Despite the small differences, some trends in the data could be identified, particularly in the categories of Shared Purpose, Social Support, Voice, Results-Driven Structure, and Collaboration. In the Shared Purpose category, Question 3 (action plans) saw the largest drop of any question on the instrument, a 0.35-point decrease between Project 1 and Project 2. As noted earlier, teams were required to assign roles and present a Gantt chart for Project 1. They were expected but not required to do this for the second project. We suspect that several teams neglected to do this step and failed to make time for discussion of action plans during Project 2.

Under Social Support, enthusiasm (Question 4) increased slightly. While this could be attributed to a preference for Project 2, previous research [1] indicates that students generally prefer Project 1. The increased score on Question 4 suggests that the teams were fostering a positive work environment.

Further evidence for positive work environments is further supported by the belief that team members were encouraged to speak up and test assumptions (Question 7). However, not all items in the Voice category saw improvement. Groups were less likely during Project 2 to believe that everyone had a chance to participate (Question 9). While exclusionary behavior could be a cause, the nature of the Project 2 assignment itself is the more likely reason. Since this project involves a lot of videography and video editing functions some people tend to dominate, either because they are the only ones that know how to do it or no one else is willing to try to figure it out.

Response patterns in the Results-Driven Structure category were interesting. On Project 2, students were less likely to believe that the members of their team understood their individual responsibilities (Question 11), possibly because the second assignment did not require the teams to explicate the role assignments, and possibly because team members lacked video-editing skills. However, teams were more likely to engage in mutual performance monitoring (Question 12), an activity necessary for effective teamwork [8]. Perhaps students had to rely more on one another because they were unsure of what to do.

Overall, teams did appear to recognize the need for high performance standards. Following Project 2, teams were less likely to believe that they possessed high standards of

excellence (Question 16), but more likely to say that they had put pressure on themselves to improve (Question 17). These changes may have occurred because teams were unhappy with their grades on Project 1 and wanted to make a better grade on Project 2.

Scores on two questions regarding collaborative climate exhibited some of the largest shifts in this study. Between Projects 1 and 2, students' belief that all team members "had a strong desire to contribute" declined (Question 19). Perhaps team members who lacked the skills to create and edit video got discouraged or chose not to contribute, leaving those with pre-existing technical knowledge to do the work. This is not surprising, since the existence of "couch potatoes" and "hitchhikers" on teams is a well-known phenomenon [24]. While we had encouraged students to read an article excerpt containing strategies for dealing with social loafers [25], we did not cover the material in class. We had hoped that the teams would read the article and discuss results from the Team Evaluation Worksheet. We also hoped that team members would address their individual shortcomings as a result as a result of these discussions. The large drop on Question 19 suggests that such discussions did not occur often, if at all.

On the positive side, students were more likely following Project 2 to believe that the team had effectively employed each member's unique skills and abilities (Question 21). Whether this change was due to the use of the Team Evaluation Worksheet is unknown; it could simply be a function of increased familiarity with team member's knowledge, skills, and abilities over time.

## VI. CONCLUSIONS

This study shows how a shared leadership module was integrated into a professional development course. A Team Evaluation Worksheet was developed to help assess the effectiveness of teams and to provide teams with feedback that can help them improve. This worksheet was tested in the fall and spring semesters of 2017. The resulting data, unfortunately, revealed little about the worksheet's potential effectiveness. The lack of change in most scores indicates that students filled out the worksheet but did not proactively or retroactively use it as a tool to enhance their teamwork. We suspect that most teams did not engage in deep discussions about their responses, even though they were given time in class to do so. We also believe that explanation of the tool itself was inconsistent across sections. Some instructors may not have fully understood the purpose of the worksheet and therefore might not have effectively encouraged its use. Finally, the collection of data at only two points in the process was determined to be insufficient.

In the future, we plan to make the following improvements to the experimental design:

- We will do a controlled study with a control group and an experimental group. Several instructors teach more than one section of Professional Development and we will recruit three of these instructors for this study. We will ask them to use the Teamwork Evaluation Worksheet as usual

for one section, but follow a newly developed protocol for their other section. The new protocol will take into consideration some of the lessons learned in this study to help us gather better data.

- For both the control and experimental groups we will keep each team of 4 to 5 students together for Projects 1, 2, and 3 rather than switching after Project 2. Students in the control group will use the Teamwork Evaluation Worksheet 3 times (once after each project), but students in the experimental group will use the Teamwork Evaluation Worksheet six times (twice for each project).
- We will provide further information regarding shared leadership, teamwork, and the teamwork assessment worksheet for instructors participating in the new study.
- We will also provide the students in the experimental group sections with more detailed explanations about shared leadership, effective teamwork, and the Team Evaluation Worksheet.
- Interviews with a subset of students and instructors regarding use of the team evaluation worksheet will be conducted.

While we were somewhat disappointed with the results of this individual study, we are not discouraged with the overall potential of this research. Culture shift is hard and students bring to this course all of their prior experience. While students are often unhappy with the performance of individual teammates, they know how to produce a product that is “good enough.” Adopting a new process, like we are attempting to do, takes time and mental effort. The students may be unwilling to add to their workload in the moment, even if that additional work has the potential for improving outcomes and reducing stressful, last-minute work. We know, as a result of this study, that we will need to provide better coaching for students in order for any teamwork intervention to be truly effective and sustainable.

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