ASEE AMERICAN SOCIETY FOR ENGINEERING EDUCATION

Paper ID #27847

Bridging the Gap: Teamwork and Leadership in Engineering Capstone Courses

Dr. Matthew J Haslam, Embry-Riddle Aeronautical University, Prescott
Dr. Mary Angela Beck, Embry-Riddle Aeronautical University

Angela Beck is a member of the Dept. of Humanities/Communications at Embry-Riddle Aeronautical University, Prescott campus. As an Associate Professor she teaches technical communications with occasional forays into applied linguistics, the philosophy of language, and ethics. She helped found and institutionalize the practice of team-teaching between her department and the College of Engineering at Embry-Riddle, and her research interests include socio-cognitive theories of expertise, methods for teaching disciplinary-specific writing strategies, and cognitive apprenticeship.

Bridging the Gap: Teamwork and Leadership in Engineering Capstone Courses

Matt Haslam, Angela Beck
Embry-Riddle Aeronautical University, Prescott

Abstract

The purpose of this paper is to describe preliminary research into how well senior engineering students are prepared to work collaboratively in capstone design courses and to report initial efforts to provide needed instruction on teamwork. Senior capstone courses in Aerospace Engineering and Mechanical Engineering (AE/ME), as instructed at Embry-Riddle Aeronautical University, Prescott AZ (ERAU), are two-semester sequences consisting of a Preliminary Design course and a Detail Design course in either Aircraft, Spacecraft, Robotics, Propulsion Systems, or Energy Engineering design. Students who are enrolled in these capstone courses form large teams (defined as more than 4 students per team) to create a design, usually in response to a Request for Proposal or a Requirements document; these student teams then analyze, manufacture (or program), and test their design. At the end of each semester, each team, under the direction of the design team lead (DTL), is required to give formal, public briefings to a panel of industry experts. At these briefings, the team members and DTL publicly defend both their technical work and their collaborative work as a team.

The primary objective of this paper is to report the preliminary results of a study conducted in Fall 2018 to determine whether senior students were prepared to work collaboratively in large teams over extended periods of time, to identify any gaps in preparation, and to pinpoint the sources of such gaps. To this end, the study's methodology included capstone team members and collecting follow-up written surveys; team composition and team projects in all required AE and ME courses were also documented and patterns identified.

The research revealed a clear gap between what was required from teams working on projects in pre-capstone courses versus capstone courses. Because typical pre-capstone projects involve two to three students working together for only a few weeks' duration, students reported being ill- prepared to work on a two-semester project as a member of a large team. Students also reported that they do not receive sufficient instruction on working collaboratively in any pre-capstone engineering course, and the DTLs interviewed felt they were unprepared to successfully discharge their required duties. They experienced difficulties making assignments, motivating team members, and ensuring that all team members do quality work.

The secondary objective of this paper is to report the initial efforts to bridge these gaps by providing capstone students with needed instruction on teamwork. This instruction includes the following:

- explaining the attitudes and behaviors team members need to develop,
- providing examples of process management tools that teams can adapt for their purposes,
- conducting out-of-class workshops for DTLs, and

- having all team members do research on effective teamwork and sharing the results of this research with their team.

Finally, recommendations for future research will be made.

Context

ERAU is a 4-year university located in Northern Arizona with an enrollment of approximately 2,700 undergraduate students. The two most populated degree programs are AE and ME[1]. Within the AE/ME curriculum, there is an emphasis on hands-on application and conceptual design projects to prepare students for senior capstone design courses.

Students majoring in AE or ME must choose one design track: Aircraft or Spacecraft for AE students, and Robotics, Propulsion Systems, or Energy for ME students. Each track culminates in a sequence of two senior capstone design courses: Preliminary Design and Detail Design.

In each of the Preliminary Design courses, students work in teams to perform conceptual and preliminary design of an overall system. In the Detail Design courses, each team typically selects a set of subsystems from their preliminary design and performs physical testing (e.g., wind tunnel testing, structural testing, flight testing). These test results are then compared to computer-based simulations and are documented in written reports, informal presentations, and a final formal briefing held during an engineering symposium[2]. If the team's project was sponsored, then the students must also present their final formal briefing to the sponsor's corporate representatives[3].

Throughout the two-semester design process, students receive instruction from both their AE/ME engineering professor and a technical communications (COM) professor who is embedded in the capstone class. The AE/ME professor assists students with technical aspects of design, simulation, and testing, and the COM professor assists students with learning how to document their work and effectively present their findings during the final formal briefing.

In addition to supporting students' technical communication, the COM professors are tasked with helping student teams to function more effectively. The ability to function in design teams is an important skill set valued by ABET and articulate in Outcome 5. As defined by the AE/ME programs, this skill set includes the ability to

- jointly set project goals and sub-goals,
- set and keep schedules to meet these goals using tools such as Gannt charts,
- communicate progress to fellow team members using tools such as status reports to provide a public record of each team member's progress,
- deliver project results in a timely fashion to fellow team members who need these results to begin their own project work,
- maintain a professional demeanor with fellow team members, even (or especially) when under stress, and
- negotiate personal or professional conflicts so that they can be quickly resolved.

In attempting to help students meet Outcome 5, the AE/ME professors have relied on the COM professors to assist in team formation and selection of DTLs. The COM professors also engage in conflict mediation using a highly structured discussion-based mediation strategy[4] whenever team members have personal or professional conflicts that impact the project and cannot be easily rectified.

The authors of this paper are both COM professors who team-teach AE/ME capstone and who each have over a decade experience team-teaching and working with large student teams. They have observed that while a few senior capstone teams are effective (i.e., they have healthy team dynamics and are highly productive), most teams are ineffective (i.e., they have unhealthy team dynamics that inhibit the progress of the students' projects; in the worst cases, the team dynamic is so unhealthy that despite repeated conflict mediation, the team project is jeopardized). Sometimes, both effective and ineffective teams work side-by-side in the same capstone class. These observations align with the literature on student teams[5, 6].

This study, then, is motivated by observations that some senior capstone students at ERAU do not seem to be prepared to work effectively in large multidisciplinary or technical teams. The key research questions this study asks are as follows:

1. Are senior capstone students prepared to work collaboratively in large teams over extended periods of time?
2. If not, what are the gaps in preparation?
3. What are the sources or locations of such gaps?
4. What type of instruction might the COM professors offer senior capstone students to help bridge these gaps?

A description of the various senior capstone design teams is provided in the next section.

Composition of Senior Capstone Design Teams

All AE/ME capstone classes are organized around team projects. Each class may have from one to four student design teams working side-by-side on different design projects. The number of students on each team can vary widely. Table 1 on the following page lists the number design teams and the number of students per design team for the most recent semester, Fall 2018:

Table 1: AE/ME Senior Capstone Team Composition, Fall 2018

Major	Track	Team Designation	Number of Students per Team
Aerospace	Aeronautics	A	8
		B	8
		C	7
		D	8
		E	8
		F	8
		G	9
		H	8
	Astronautics	I	10
		J	10
		K	8
Aerospace (cont'd)		L	7
		M	4
		N	11
Mechanical	Robotics	O	6
	Propulsion Systems	P	6
		Q	7
		R	5
	Energy	S	5
	Average Students Per Team		**7.5**

As summarized above, each design team in Fall 2018 ranged in size from 4 to 11 students, with an average of 7 students per team; past design teams have ranged in size from 3 to 32 students.

Each team is managed by a DTL. The DTL selection process is up to the capstone professors' discretion. The DTL is often appointed by the professors after a formal interview process, but they are sometimes selected by fellow team members by team vote. Occasionally, a team will have two co-DTLs who share leadership responsibilities. The DTL's responsibilities include:

- Scheduling tasks, including out-of-class meetings, documentation writing sessions, and "dry runs" for the final formal briefing,
- Assigning tasks to teammates, including assigning extra help to teammates who are struggling with their tasking,
- Motivating team members to complete tasks on time,
- Mediating personal or professional conflicts,
- Running weekly status report meetings,

- Overseeing the manufacture of the design,
- Managing manufacturing budgets,
- Managing risk, including test safety,
- Overseeing the compilation, editing, and revising of all required documentation,
- Submitting drawing packages, test plans, test reports, and other supplementary documentation to the capstone professors,
- Submitting the final project report to the capstone professors,
- Leading the final formal presentation, including the question/answer sessions, and
- Serving as liaison between the capstone professors, corporate sponsor, support staff (e.g., college budget manager, machine shop manager, lab technicians), and the design team.

Teams may also have an Assistant Team Lead (ATL) or a Chief Engineer (CE). The selection process is up to the capstone professors' discretion, and many teams do not have an ATL or CE. Teams that do have an ATL or CE select these members by team vote. The primary purpose of the ATL/CE position is to lighten the DTL's load, which can be significantly heavy if the DTL's team is large or has a corporate sponsor. The ATL/CE's take over some of the responsibilities of the DTL, most typically the following:

- Overseeing the manufacture of the design,
- Managing risk, including test safety,
- Overseeing the compilation, editing, and revising of all required documentation, and
- Serving as liaison between the support staff (e.g., college budget manager, machine shop manager, lab technicians) and the design team.

In summary, most senior capstone design teams at ERAU are large teams; they are composed of approximately 7 team members, working under the leadership of a DTL (and perhaps an ATL or CE) to design, manufacture, and test a complex project over the course of 2 semesters, with all the attendant documentation and presentation that such a project requires.

Whether or not students in these large design teams are prepared to function effectively over the course of a year is discussed in the following section.

Methodology

For this study, data were collected using two methods: interviews with an attendant follow-up survey and course reviews.

Interviews

Interviews were conducted with senior engineering students who were enrolled in two of the Detail Design courses. All 46 students enrolled in these courses were invited to participate in these interviews; 12 of the students who participated were enrolled in Aircraft Detail Design, and 11 were enrolled in Propulsion Systems Detail Design. Approval from the campus' Institutional Review Board (IRB) was obtained for this project, the IRB vetted all scripted interview questions, and all students signed a consent form prior to their interviews. Each interview lasted approximately 30 minutes, followed scripted questions allowing open-ended responses, and was audio recorded.

Of the students interviewed, 12 students were currently serving as their team's DTL or co-DTL, or they had been the DTL or co-DTL the previous semester in Preliminary Design. For the DTLs the interview questions focused on the challenges they faced in leading their teams, what they understood their responsibilities as DTL to be, and what experiences or instruction had prepared them to lead their teams. They were also asked to assess their performance as a DTL and how well their team worked together.

The other 11 students interviewed had not served as DTL or co-DTL. They were asked to identify any projects completed in pre-capstone courses that had required them to work collaboratively with other students; they were then asked to compare the tasks undertaken in these pre-capstone courses with those tasks required by their capstone courses. They were also asked to identify any experiences or instruction that had prepared them to work in capstone teams.

Once the interviews with the 23 students were completed, the responses were analyzed to identify gaps in preparation for working in large teams. Based on the identified gaps, a survey was devised to explore student recommendations as to how they could have been better prepared. A link to a survey was sent to all 46 students enrolled in both courses; 40 of the students completed the survey. Three of the student recommendations pertinent to this discussion were as follows:

- Students should receive instruction regarding how to work effectively in teams in pre- capstone courses.
- Students should receive instruction regarding how to lead teams in pre-capstone courses.
- Pre-capstone courses should have projects that require the formation of formal teams led by DTL's.

Course Reviews

In their interviews and follow-up surveys, students claimed to have little preparation working in large teams in their pre-capstone courses. To test this claim, a course review was conducted. With the help of student research assistants, one of the authors collected all syllabi, assignments, and other course documentation for all 15 AE courses and 3 of the 5 ME courses which engineering students must take at ERAU before their capstone sequence. These documents were analyzed; all teamwork, team documentation, and team presentation requirements were identified and recorded. For each pre-capstone course, the analysis included the following information:

- whether students were required to work in teams,
- the number of teams formed in each class,
- each team's size,
- how long each team worked together,
- a description of each team's project,
- required writing assignment(s), if any, and
- required presentation(s), if any.

All data were recorded; findings are discussed in the following section.

Results

Interview Findings

The interviews revealed was that little attempt was made in any engineering course prior to the capstone courses to provide instruction on working on teams or leading teams. One AE student described the "sink or swim" approach teamwork in his courses. He specifically referenced dealing with conflict in team settings, indicating that he had to learn from experience how to address and negotiate conflicts. It is well documented in the literature on teamwork in academic classroom settings that this student's experience represents the norm: students are expected to work in teams without receiving instruction on how to work in teams[5].

When asked what prepared them to work in capstone teams or lead these teams, not one student referenced a prior engineering course experience. Instead, students identified co-curricular projects, such as the university-sponsored jet dragster program or an AIAA competition. They referenced work in campus clubs, including leadership positions. As the campus has a large detachment of Air Force ROTC cadets, these interviewees referenced both their leadership coursework and experiences leading fellow cadets. Others described their active military duty, including service in the Army and Coast Guard. Internships also provided valuable experience, with one student commenting that his internship required him to compromise with what he described as "difficult people." When interviewees mentioned academic courses, it was an Honors course that focused on leadership or a Technical Report Writing course that required a semester- long teamwork project – not an engineering course.

In addition to these expected sources of teamwork and leadership experience, students also cited a range of personal activities. One student described how he was benefited by working as crew chief of a racing team in which he learned to trust others. An AE student mentioned her opportunities to instruct others in martial arts whereas another cited her experience co-captaining a soccer team plagued by internal dissent. One student mentioned that he had taken the initiative to read extensively on leadership topics so that he would be better prepared for the workplace.

In summary, students reported little to no preparation prior to their senior capstone design courses for working in large teams over long periods of time on complex projects.

Course Review Findings

A review of pre-capstone courses provided data on team sizes and types of team projects, as summarized in Table 2 and Table 3:

Table 2: Team Projects in Required Courses for Both Degrees

Track	# of Courses w/ Groups	Groups of 2-3	Groups of 4-5	Example Group Products
All	6	5*	2*	Lab reports PDR & CDR presentations Design presentations Design report & presentation

* In EGR 101: Introduction to Engineering, students work in a 2-person team for 3 weeks and a 4-person team for 6 weeks.

Table 3: Team Projects in Required Courses by Track

Track	# of Courses w/ Groups	Groups of 2-3	Groups of 4-5	Example Group Products
Aero	4	2	2	Matlab projects 6 lab reports 5-page report 25-page report
Astro	3	1	2	Matlab projects Cube Sat design report 25-page report
Robotics	2	1	1	Lab reports Design report
Propulsion	1	0	1	Lab reports
Energy	1	0	1	Lab reports

A review of the projects required in courses that AE and ME students take prior to capstone reveals some of the reasons students did not cite the engineering projects as preparing them for the teamwork and leadership tasks required in capstone. Table 4 highlights the way these pre-capstone projects differ from the projects completed in capstone courses.

Table 4: Pre-capstone Projects Compared with Capstone Projects

	Pre-capstone Projects	Capstone Projects
Team Size	2 – 5	5 – 14
Team Duration	Varies from 1 week to the full semester	2 semesters
Team Structure	Informal, often comprised of friends	Formal team w/ team lead and assigned roles
Scope	Distinct projects that last 2 – 5 weeks 1 – 5 hours a week 5- to 25-page reports Only 2 required EGR courses include presentations	Requires 28 weeks to attempt to complete 10 – 18 hours per week 30- to 100-page reports 5 – 8 presentations over 2 semesters

Analysis of the data provided by the interviews and course reviews revealed a critical gap between pre-capstone and capstone courses in how teams are formed and how they function. Of note, the team projects all differ in team size, the duration of the team project, the structure of teams, scope of the project, and the deliverables required. These key findings are reported below.

Team Size and Duration

All of the pre-capstone team projects were short in duration, lasting from two to five weeks. Even in the course that required students to work together for an entire semester, the team completed two multiple-week projects rather than a single project that extended throughout the semester. This short duration has important implications for how students approach their projects. Students describe developing a "get the project done" mentality in which conflicts are ignored in the expediency of completing the task. With this approach students learn to put up with the unreasonableness of other team members, and they often compensate for the inadequate performance of others. Given the short duration the students do not acknowledge, address, or resolve their conflicts. They may thus be unprepared to address conflicts when they reach their capstone courses.

Multiple students recommended that pre-capstone courses should involve expanded projects in terms of size and duration. One student wrote in response to the open-ended survey question that engineering students should be given "more chances to work in larger groups, all engineering classes should [have] a project that can be worked on throughout the semester that allows them to work as a team while completing an extended project." Another student

suggested in labs that professors ought to "assign more large, multi-week projects" that would give students "experience planning work sessions for longer projects."

Team Structure

For nearly all of the team projects in the engineering curriculum, students were allowed to form their own teams, which typically meant they got together with friends. The option to work with friends had important implications for how the teams were organized and how the work was carried out. None of the students interviewed reported having a pre-capstone team that had a formal team lead or DTL. Without a clear team structure the students lamented that their teams often lacked a method to ensure complete participation by all team members or ensure the quality of work met the expectations of the entire team. Thus, by the time they entered their capstone courses they had not learned methods for creating balanced participation nor for controlling the quality of team-authored documents and presentations.

In response to the open-ended survey question, one student pointed out "There [are] not enough team projects with people outside of your friends, which does not necessarily support team work and communication. This needs to be emphasized more before getting to the capstones." Others specifically wanted more teams with assigned team leads that could address the weaknesses of friend-based teams and which could provide valuable experience leading their fellow engineering students.

Project Scope

The interviews provided insight into the problem with pre-capstone projects: the scope and complexity of many projects were limited such that a single individual could complete the project working alone. Moreover, students discussed taking over a project when a teammate did not share the same grade expectations or failed to complete assigned tasks. Other projects required limited interaction among the team members. Rather than teamwork, the individuals produced what can be described as combined individual work. They met together to identify requirements, then made assignments, and the work was completed individually. The team would then meet, typically just before the deadline, to combine the different components. These pre-capstone projects, then, are not structured like capstone projects, and do not prepare students to undertake true teamwork.

Two students commented on the lack of complexity in the required team projects. One student complained that too many pre-capstone projects simply involved following the steps prescribed by the instructor, while the other suggested that most lab reports could be completed individually. What was needed were pre-capstone courses that "have a layout similar to the one seen in the capstone courses." The courses should "require that team leads in formal groups have to go about setting deadlines and group meetings with the guidance of the professor instead of the profess[or] just stating when everything needs to be done." These students wanted projects that demanded more of them in terms of figuring out what is involved in a project: planning tasks, setting deadlines, including intermediate deadlines, and determining how best to go forward with a project.

Deliverables

Two students acknowledged the challenges their teams faced in producing the requisite documentation in the capstone courses. It was one student's opinion that "the biggest issue that plagues the capstone courses is group reports and presentations." The students have not been required to complete products that are so involved and demand attention to detail on such a scale. Unlike capstone projects, which are long in duration and complex in scope, pre-capstone projects tend to be short in duration, perhaps only a week or two long, and simple enough that one student could complete the project, as noted above.

The result, according to this student, is that "we go in blind" to capstone as to what to expect. This sentiment was echoed by another student who explained "the team I am on is full of intelligent people who know what they are doing from a technical perspective. Unfortunately, at the start of the first semester, we were unsure of how to work together on technical reports because everyone had had different experiences in other courses. If other courses gave insight into how reports and groups work in capstone courses, the initial shock of capstone could have been avoided."

Conclusions and Recommendations

This paper has highlighted the gaps that senior capstone students experience when shifting from small, informal teams working on short-term projects in their pre-capstone classes to large, formal teams working on long- term projects in their senior capstone classes. This study revealed that senior capstone students report that they are not prepared by their pre-capstone courses to work collaboratively in large teams over extended periods of time. The gaps in preparation are multiple. Students report being unprepared to work in large teams, across long stretches of time, on complex projects, with personality and professional conflicts arising that cannot be simply overlooked.

Professors at other universities acknowledge that it is all too often that students are asked to work in teams without being provided any instruction on how to do so.[5] Lingard and Barkataki point out that "most programs do little to teach these [teamwork] skills. Typically, they give students many opportunities to participate in team projects, but they do little to help students develop or improve specific teamwork skills"[6]. This research documents a similar finding in that engineering students were asked to work in teams without receiving instruction on teamwork or guidance on how to develop needed skills.

As indicated by the interview and course review data, pre-capstone courses typically have team projects that only require small teams of two to three students; these teams are usually formed by friends grouping together and such groups rarely have team leads or DTLs. These pre-capstone teams work together for a short period, and conflicts are typically overlooked so that students can cobble together independent work into a "team" product. This study indicates that the nature of teams and teamwork in pre-capstone courses is, in short, radically different from the nature of teams and teamwork in capstone courses.

Recommended Instruction

Closing this preparation gap altogether at ERAU would require global changes throughout the engineering curriculum. Bridging this gap, however, can be accomplished through localized

changes in instruction offered by the COM professors team-teaching the senior design capstone courses. Researchers are in agreement that students need to be given specific opportunities to develop the knowledge, skills, and abilities (often referred to as KSAs) associated with working in teams[7, 8].

To develop the students' knowledge of effective teamwork, a series of five in-class presentations, each about 30 minutes long and based on best practices found in the literature, have been developed as a possible instructional intervention by the COM professors. The presentations address the following topics: Organizing the Capstone Team, Creating a Positive Team Culture, Learning as a Team, Making Decisions and Addressing Conflicts, and Developing Communication Skills. A primary objective for the presentations is to persuade capstone teams to do what the research says effective teams do. The initial presentation on organizing the capstone team is based on recommendations gathered from the interviews cited in this report, while the remaining presentations are based on a literature review written by Eduardo Salas and colleagues that outline the "the attitudes, behaviors and cognitions that constitute team competencies"[9]. The competencies outlined in the report serve as a checklist for the teams as they work together during the two semesters.

Each presentation is supported by a series of individual and team tasks the students complete. For example, individual team members are asked to self-assess their performance in prior teams and identify individual skills they will intentionally seek to develop over the course of the two semesters. Each student identifies goals to work on and seeks feedback from their teammates. In conjunction with the presentation on organizing a team, each team completes a written contract that outlines team goals, roles, and rules. Following the Learning as a Team presentation, which emphasizes the need to develop and maintain a learning orientation throughout the project, teams complete a series of debriefs / performance critiques related to the written documents, oral presentations, and team interactions.

Other engineering programs may develop similar strategies to close the preparation gap at their own institutions. Once they decide what knowledge students need (e.g., how to make group decisions, how to mediate conflict, how to develop a team-first attitude), they can design exercises that allow students to practice the requisite skills and abilities. These exercises may be developed with the assistance of colleagues from communication, business, or engineering management. Once students complete these exercises, they can be given needed feedback. By providing iterative practice, engineering faculty may be able to help their students acquire the necessary team-related KSAs and bridge this gap.

Further Research

This study has demonstrated the disconnect between the lack of instruction that student teams receive in pre-capstone courses and the expectation that student teams perform at a high level in capstone teams. It has also recommended a pedagogical approach, based on the literature, for helping students learn to function more effectively in teams in their capstone courses. Questions for future research include the following:

1. Does the instructional method described in this study provide sufficient instruction to "bridge the gap" and allow students to function effectively in their capstone teams?
2. What specific changes to the AE/ME curriculum might help close the gap in team preparation so that last-minute pedagogical interventions become unnecessary?
3. How might DTLs be trained to be effective leaders before they reach capstone?

References

1 Embry-Riddle Aeronautical University, Office of Institutional Research. (2018). *Enrollment Fact Sheets: Fall 2018*. Retrieved from https://ir.erau.edu/Publications/Factsheet/PDF/Factsheet_FA18.pdf

2 Helbling, Jim, and Beck, Angela. (2016). *Inception and Evolution of a Capstone Design Symposium*. Proceedings of the 2016 American Society for Engineering Education Pacific Southwest Conference. Pomona, CA, April 2016.

3 Helbling, Jim, and Beck, Angela. (2014). *Seeking Student Success Through Industry Partnership in Senior Capstone Design*. Proceedings of the 2014 American Society for Engineering Education Pacific Southwest Conference. Long Beach, CA, April 2014.

4 Helbling, Jim, and Beck, Angela. (2010) *Configuration of Senior Capstone Course Using Team-teaching to Maximize Communication Skills and Minimize Conflict*. Proceedings of the 2010 American Society for Engineering Education Pacific Southwest Conference. Reno, NV, March 2010

5 Holmer, Leanna. (2001) Will we Teach Leadership or Skilled Incompetence of Student Project Teams. *Journal of Management Education*. *25*, 590-605.

6 Lingard, Robert, and Barkataki, Shan. (2011). *Teaching Teamwork in Engineering and Computer Science*. Proceedings of the 41st ASEE/IEEE Frontiers in Education Conference. Rapid City, SD, October 2011.

7 Chen, Gilad, Donahue, Lisa M., and Klimoski, Richard J. (2004). Training Undergraduates to Work in Organizational Teams. *Academy of Management Learning and Education*. *3*, 27-40.

8 Hughes, Richard L., and Jones, Steven K. (2011). Developing and Assessing College Students Teamwork Skills. *New Directions for Institutional Research*, *149*, 53-64.

9 Salas, Eduardo, Rosen, Michael A., Burke, C. Shawn, & Goodwin, Gerald F. (2009) The Wisdom of Collectives in Organizations: An Update of the Teamwork Competencies. In *Team Effectiveness in Complex Organizations: Cross-disciplinary Perspectives and Approaches* (pp. 39–79): New York: Routledge/Taylor & Francis Group.