Developing an Integrated Curriculum-wide Teamwork Instructional Strategy

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Abstract

Graduating engineering students need many technical and professional skills to be successful in their careers, including those in communication and teamwork. The School of Chemical, Biological and Environmental Engineering (CBEE) at Oregon State University administers three undergraduate degree programs, and the curriculums have many courses, which incorporate teamwork and group activities (often multidisciplinary). However, until recently students did not receive targeted instruction in productive and inclusive teaming. To decrease student challenges with teamwork in their senior design courses and to produce competent and credible engineering graduates, we aim to incorporate teamwork knowledge and skill instruction into the curricula in a scaffolded, progressive manner. We have a unique opportunity given that our unit supports three disciplinary programs that have substantial overlapping curricula and has numerous opportunities for team activities at all course levels (first through fourth year), despite large class sizes.

As a first step to enriching the curriculum with teaming instruction, modules and activities for the senior level lab and design courses have been implemented. Using evidence-based concepts and practices, the activities were designed to be directly relevant to the course material, designed to enrich, not simply amend, course content. All efforts were based upon a conceptual framework for teamwork knowledge, skills and functionality that moves the knowledge of teamwork into the practice of teamwork. The aim is for students to develop sustained practices in communication, inclusion, self-reflection, conflict management and team norming. Here we report progress of our efforts in the senior year, including discussion of assessment data, and end with a brief view towards the longer-range goal of stretching the teaming instruction across the four-year programs.

Keywords: Teamwork, Engineering, Evidence-based practice

Introduction

Engineering work relies on effective collaboration and communication among diverse groups of engineers and scientists, and engagement in partnership with broader constituencies (managers, technicians, end users, among others). There is a long-standing expectation that graduates from engineering programs be proficient communicators and team members, and outcomes relevant to communication and teaming survived the recent re-visioning of ABET criterion 3 (Graduates will have … "an ability to function effectively on a team whose members together provide leadership, create a collaborative and inclusive environment, establish goals, plan tasks, and meet objectives" and "an ability to communicate effectively with a range of audiences"). As would be expected, a significant amount of research has been conducted in these areas, targeting general knowledge and skill development [1]–[5], team formation [6]–[8], team assessment [9]–[12], conflict management/team problems [13], the importance of campus culture and social interactions [14], and team diversity [15]–[18]. Yet many programs continue to struggle with the delivery of strategic and progressive instruction that prepares graduates to engage consistently in productive and inclusive teaming practice.

Context

The undergraduate programs administered in CBEE require extensive group and teamwork throughout all four years of the curricula; however, instruction on effective and inclusive practices is only occasional, and if present the outcomes are rarely assessed. To address this deficit, our unit is re-visioning teaming instruction across the four-year curricula, developing intentional, progressive active learning experiences aimed to enhance students' capacities to engage in functional and inclusive teaming practices. The curriculum-wide design is ideal for spaced and interleaved practice, which has been shown to enhance long-term learning outcomes, though these outcomes are not assessed in this study. [19]

Opportunities: course structure

The curricula of the three programs administered have substantial course overlap during the first three years, resulting in large course enrollments (150-250 students). However, these core courses have been designed to provide students with opportunities to actively apply concepts presented in lecture through team-based studios (24 or fewer students). During students' latter years in their programs, discipline-specific laboratory and design sequences provide additional opportunities to enhance teaming knowledge and skills. The three distinct instructional spaces are:

Studios. Most of the large-enrollment courses consist of a lecture component supported by smaller studio sections. During studios, students actively apply concepts and problem-solving procedures as they work in teams. The presented tasks are designed as professional engineering problems where learners take the role of practitioners working on a team. The orientation is practice-to-concept, where the tasks require students to use core concepts and practices as tools in the context of real (and messy) engineering work [20].

Laboratory. Students enroll in a three laboratory sequence during their third and fourth-year curriculum. The majority of tasks are completed in teams. The hands-on experimental activities include experimental design, equipment assembly and trouble-shooting. A virtual lab may also be completed, which simulates and allows for many more experimental runs and data collection than a hands-on lab [21]. The lab curriculum becomes more open-ended with increased need for experimental design as the students progress through the lab sequence.

Design. Two terms of discipline-specific senior design are completed during the fourth-year curriculum. Typically, the major projects are open-ended and team based. A large amount of outside class time coordination is required among the teams, so teamwork skills are a strong need at this level. By piloting studies at this level, we are identifying needs and compiling lessons learned to apply to the entirety of the curricula.

Development and revision strategy

The long-range goal of our efforts is the design and implementation of progressive learning experiences situated across all four-years of the three undergraduate programs that enhance students' capacities to engage in functional teaming practice. Our initial efforts include CBEE faculty participation in a yearlong Professional Learning Community (PLC) focused on the design of instructional content, pedagogy and assessment metrics for productive, inclusive and socially just teaming practices. This inquiry-based learning opportunity provides a platform for

participants to adapt evidence-based practices reported in the literature to the contexts presented in our unit. Sub-groups have identified particular components of teaming instruction in which to focus efforts, including, practices of team formation, teamwork assessment, knowledge and knowing supporting socially-just teaming practice, and conflict management and teamwork trouble-shooting. Progress along each of these initiatives is discussed during meetings of the PLC, with focused interventions emerging for coursework situated in the first and fourth years of our programs. A faculty sub-group is developing curricula for orientation courses that introduce concepts supporting socially just engineering practice, including inclusive teaming. Students' will have opportunities to explore ideologies (meritocracy, depoliticization and the social/technical dualism) framing current engineering culture that pose barriers to the evolution of engineering into a socially just profession [22]. We aspire to centralize the social and political dimensions of engineering so that they stand firmly beside the technical dimension.

While not yet defined, critical pedagogies such as product archeology [23] will be used to move students into and through these conversations. In parallel, faculty sub-groups are designing functional teaming curricula that is currently being piloted in our senior laboratory and design sequences. The remainder of this paper will discuss activities developed and implemented in the senior level coursework this year, and will end with a short statement of how this work will be extended in subsequent years.

Approach

Using teamwork as an instructional tool has been shown to lead to greater gains in conceptual understanding, more creative thinking, and better ability to develop disciplinary language fluency [24]. We capitalize on this through providing intentional and focused teaming instruction first in the senior-level laboratory and design courses. Our curricular revision was guided by evidence-based practices and the principles of cooperative learning [25]. Several practices central to our initial reframing of teaming development are (i) team norming, (ii) instruction in effective teaming practices and teamwork fundamentals, and (iii) attention to the importance of both knowledge and knowing. The former (i) addresses the formation of clear team expectations and involves formal team agreements [26]. Teamwork fundamental instruction (ii) is based on several teamwork fundamentals that have been shown to provide a strong basis for high team functionality, and allow for team improvement when consistently applied and practiced. In particular, Davis and Ulseth [27] identified and described six such principles: teams have two goals (team development and project completion); teams require both individual contributions and team effective team processes; feedback is required for team improvement; teams must articulate desired team performance metrics; team members must be held accountable for expected performances; and, team processes must be clearly defined and communicated so that team members understand expectations.

The activities are designed with the consideration that students can understand the concepts that support effective teaming practice (knowledge) but still lack the process skills required to consistently engage in such practice (knowing) (iii) [28]. Ideally students should be capable of applying knowledge of effective teaming practice into in their professional lives. In order for them to achieve knowing, they need to repeated opportunities to rehearse these skills. Students

often view course assignments as either content or practice, but not both; however, we aim to design activities that require them to apply both.

Curriculum

The conceptual framework introduced/developed by Davis et al. served as a foundation for the fundamental instruction and was incorporated into the subsequent teamwork activities to reinforce its concepts in Fall 2017 (Table 1) [27]. Brief formal instruction on this framework was provided in Fall 2017, and was not the main focus of the activities in order to reinforce knowing over knowledge.

The curriculum modules piloted in Fall 2017 were an initial team formation exercise, either a team contract or team resume, a mid-term team refinement, and a final reflection survey (see Appendix for examples). The team contract and resume are worksheets for the teams to complete together during class time. They guide the students through best practices for team formation and are prompted with thought questions for team norms, motivation, goals and performance measures. Mid-way through teaming for the term, a team refinement activity is designed to have the students analyze their team experience and functionality, as well as self-reflect on their own behavior. In addition, the teams revisit their performance definitions to adjust as necessary.

The initial team formation activities were also repeated for Winter 2018 courses, and a conflict resolution module series has been incorporated to build on the Fall 2017 activities (Table 1). The module consists of an initial conflict handling mode training workshop, a mid-term conflict resolution reflection, and a final reflection survey.

Assessment

Fourth-year students from all three disciplines, chemical, biological and environmental engineering, were surveyed after Fall term 2017 on their perceptions of teamwork culture, team formation practices, and teamwork curriculum implemented in Fall 2017. Likert scale and open-ended questions were used. The survey was administered through Qualtrics and the responses were collected anonymously (Table 2). Data collection of teamwork skills and perceptions is ongoing throughout the AY17-18.

Table 1. Courses which included teamwork activities AY17-18. Instruction type is in parenthesis with enrollment numbers in brackets (*projected).

Fall 2017	Winter 2018	Spring 2018
CBEE 414 (lab) [185]	CHE 431 (design) [128]	CHE 432 (design) [128*]
BIOE 490 (design) [48]	BIOE 415 (design/lab) [42]	
CHE 443 (studio) [67]		

Table 2. Excerpt of survey completed by students at the end of Fall 2017. The students rated the statements on a five-part Likert scale (strongly agree, somewhat agree, neither agree nor disagree, somewhat disagree or strongly disagree). They are organized by assessment metric, but were delivered in a different order in the survey. Examples were often given with the prompt, but are excluded here for concision.

Assess teamwork culture				
I learned something about at least one of my teammates' interests or hobbies outside of class through the process of being on their team in CBEE414.	Teams in CBEE course are inclusive-they engage members regardless of differences (gender, identity, race, nationality, language).	I think the products of teamwork are usually better quality than the products of work I complete individually.		
I appreciated that I was paired with student(s) of a different discipline(s).	I learned something from the student(s) on my team with a different discipline.	My social identity impacts the way I interact or am perceived on a team in CBEE.	All of my teammates contributed uniquely to the team products (This does not mean equal quality or amount of contributions).	
Assess teamwork activities				
The teamwork activities helped me be accountable for my commitments and contributions to the team's work.	The teamwork activities improved the accountability of each teammate.	The teamwork activities helped us balance the workload among team members.	The teamwork activities improved our team products.	Overall, the teamwork activities helped my team reach our goals.
The teamwork activities helped my team set expectations for how we would interact as a team.	The teamwork activities helped us develop standards for acceptable team member performance.	The teamwork activities helped me understand the components of team functionality.	The teamwork activities improved my ability to give my teammates feedback (either on the work they were contributing or to how they were interacting with the team).	

Results and Discussion

The assessment of the curriculum modules developed began with an end of Fall 2017 term survey. Of the 185 survey requests, a total of 177 responses were collected.

Evaluative Survey

Teamwork curriculum

The curriculum implemented in Fall 2017 was broadly accepted with few complaints and some vocal appreciation. The discussion of teamwork fundamentals was new to most students, so we framed the activities in the context of improving their ability to implement engineering projects in their careers. The context framing of the activity was important to encourage students to fully participate. Overall, students reported the activities allow them a structured space to begin discussions which are sometimes uncomfortable whether due to past tensions, new faces, priority differences, etc. Specifically, the teamwork activities were perceived by 60% of respondents as helpful to understanding the components of team functionality (knowledge instead of knowing).

The initial team formation activity established team structure, communications, expectations, and goals (Example, Figure 1). The students were asked to define team interactions such as decision making protocols and communication methods. The students found establishing methods and limits for team communications, such as how quickly text messages must be responded to, the most helpful (82% somewhat or strongly agreed) (Figure 2). Also, 80% somewhat or strongly agreed that discussing individual expectations was also worthwhile. Least helpful was the discussion of team norms at only 67% somewhat or strongly agreed. However, this was likely attributed to the unfamiliar terminology of 'team norms.'

In CBEE414, the senior lab course, the mid-term activity was framed in context of their next lab project which was a virtual bioreactor lab. For example, the students were encouraged to focus on positive teammate behavior, but be critical of their own (Table 3). Based on personal feedback, the students thought the check-in was a valuable exercise as the nature of the virtual lab required more coordination outside class time.

INTEROFFICE MEMORANDUM – EFFICIENT BIOETHANOL, LLC

TO: EB PROCESS ENGINEERS
FROM: CORPORATE STAFF DEVELOPMENT
SUBJECT: TEAM CONTRACT
DATE: SEPTEMBER 25, 2017

To promote high-functioning, successful teaming, EB, LLC encourages all teams to complete the following team contract prior to beginning work on team tasks. Please spend at least 15 minutes to normalize your team expectations.

TEAM CONTRACT

Mission

Norms

Goals

Performance Measurement

Use the following questions to guide your team contract formation. Sign the contract when complete.

Figure 1. Example text from a team formation/norming exercise used in the Fall of 2017. The course material was presented as a professional project with the students as employees.

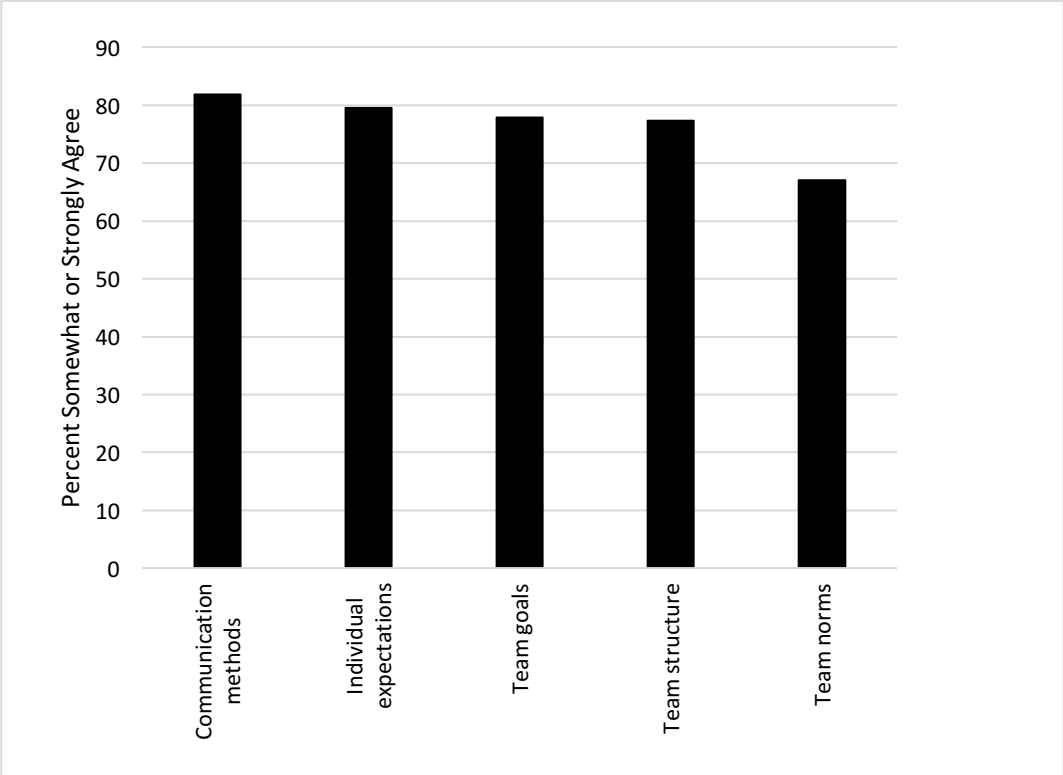

Figure 2. Percent of survey respondents strongly or somewhat agreeing with Likert scale prompts about teamwork activities implemented Fall 2017. The prompt for each category was: It was helpful to think about the following aspects of teamwork for my CBEE414 or BIOE490 course work and team projects.

Table 3. Example prompts from mid-term team check-in activity in CBEE 414, Fall 2017

Team Reflection Reflect on behaviors you have noticed about others that are positive and have helped your team function well. List a positive thing about each of your teammates. When done, discuss as a team. Refrain from saying anything that you think others' may need to improve.
Performance Definitions Review the Performance Measurement section of your Team Contract signed the first week of lab. Discuss as a team. Do you still agree with your list or would you suggest any changes? Note any changes below. List one way your team can improve its cohesiveness.
Improvement Ideas/Feedback Loop Discuss each team member's thoughts on which team behaviors would make the remainder of CBEE414 an effective, inspiring, enjoyable, and stress free experience. Examples include: clear communication with specifics of how the team prefers to communicate, best ways for the team to meet and interact (mornings with coffee, evenings in the library, Gleeson, etc.). Also list one of your own behaviors that you could improve to help your team.

Both the initial activity and mid-term check-in were found to be valuable by some students, though 60% thought the initial activities were the most helpful. It seems reasonable that students' perceptions of which activity was most valuable is related to which types of conflict arise. If no uncomfortable conflict was present, then less team refinement felt needed and the mid-term activity seemed less useful.

Overall, the activities were perceived to be the most impactful for setting standards of team member performance, expectations for team interactions and personal accountability. However, improvements in the activities are needed to help students balance workloads, feel like they are improving their teamwork skills and final team products. A discussion on the definition of a "balanced" workload could better define what students mean when they answer that type of survey question. One of our goals was to help students improve team development in order to better complete their projects. Although 56% of respondents thought the activities help the team reach their goals and a similar number for improving team functionality, only 48% thought they improved their final team products. Measuring project improvement was a challenge, and one possibility is developing methods for comparing team project scores with individual scores on other course assignments.

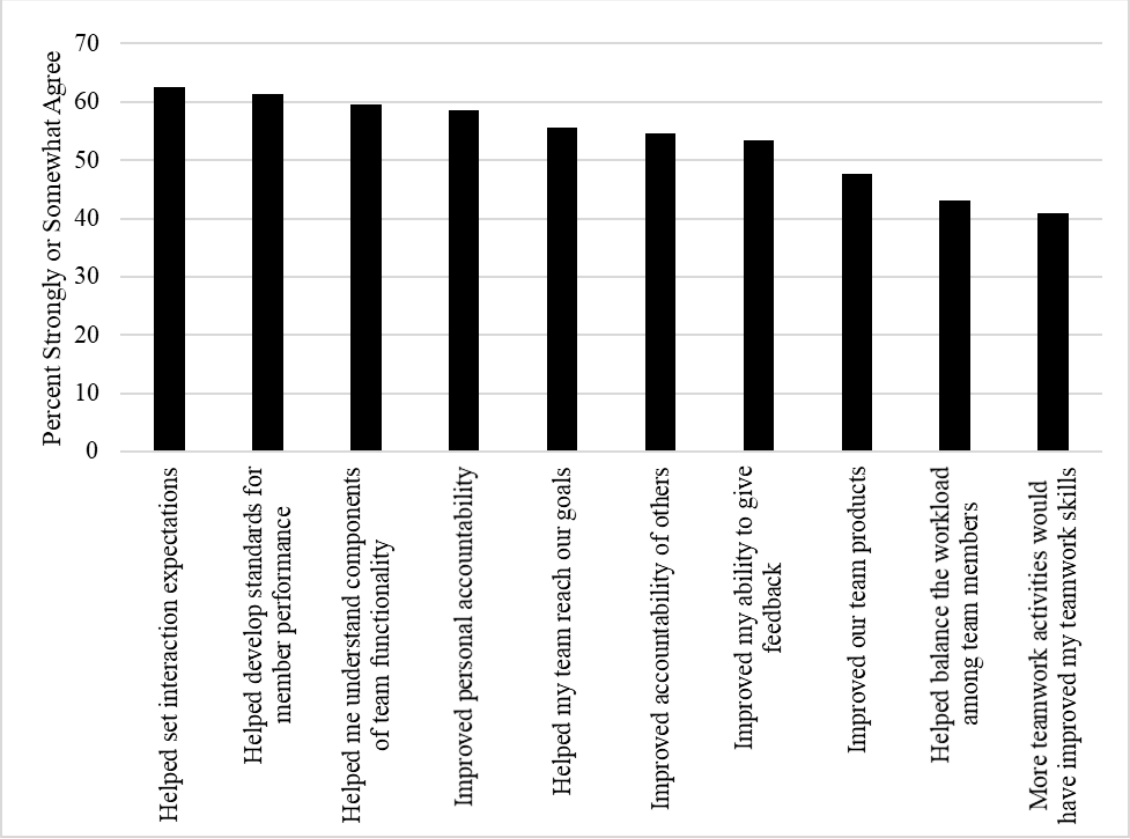

Figure 3. Percent of survey respondents strongly or somewhat agreeing with Likert scale prompts about teamwork activities implemented Fall 2017. The survey text has been summarized to allow graphical representation. For example, "Helped set interaction expectations" is the summary of the prompt "The teamwork activities helped my team set expectations for how we would interact as a team (e.g. when to hold meetings, how to communicate or what each individual would contribute)." The entire prompt is detailed in the Appendix.

Three activities per 10 week term was a reasonable number, and only 40% thought more activities would have helped more (Figure 3). So, the number and level of activities were appropriate for this group or the effectiveness of the activities was too low. The activities effectiveness could improve with iteration and beyond the impact of actually improving the team products, or the perception of impact could increase independently. In the future, as the teamwork training tasks are distributed through all levels of the curriculum, less activities or less time per activity could be achievable in the senior level courses.

Teamwork culture in CBEE

The culture of teaming in CBEE was positively viewed by most respondents. They saw that team products are higher quality than individual products (74% strongly or somewhat agree) and multidisciplinary teams were a positive learning experience (Figure 4). For example, majority (74%) reported they enjoyed working in multidisciplinary groups, and a large percentage (71%) said they learned something from their teammate with a different discipline. This result is interesting, because the majority (70%) of the enrolled students were chemical engineering majors, so large portion of respondents would be referring to biological or environmental engineering majors. This shows respect between the three disciplines, where often there is an assumed hierarchy with chemical engineers at the top. Some students (all chemical engineers) were not teamed with members of different disciplines due to student enrollment ratios, so these numbers would likely increase if that had been a control factor.

In response to "Teams in CBEE are inclusive – they engage members regardless of differences," 91% of respondents strongly or somewhat agreed (Figure 4). In addition, the formation of teams by the instructors, as opposed to self-selection, helped the students get to know each other. 83% reporting learning something about a teammate's hobbies or interests as a result on being on a technical team. It was not clear how the activities could have impacted the overall culture, as data was not collected before implementing the activities.

Team challenges

The main challenges of teamwork in CBEE were reported as finding time to meet outside of class (scheduling) and using constructive feedback as a tool. To address the first issue, we used the CATME team formation tool *Team-Maker* [6], which allows schedule considerations, for Winter 2018. Constructive feedback was a bit trickier, whether asking for teammates to contribute, to let go of strongly held opinions or having frank discussions on how the team is functioning, this aspect of teamwork has roots in personality, personal identity, and social skills among others. While engineers lack a stellar reputation in the social skill realm, there is a level of difficulty to constructive feedback and conflict resolution regardless of profession, with experience and practice being key in improvement. In order to meet our objective of developing student skills, modules will need to be developed to assist students with constructive feedback. Possibilities being explored include role playing, brainstorming solutions to difficult team problems, and using the CATME peer evaluation tools [29]. Our on-going efforts are focused on modules specifically around conflict resolution.

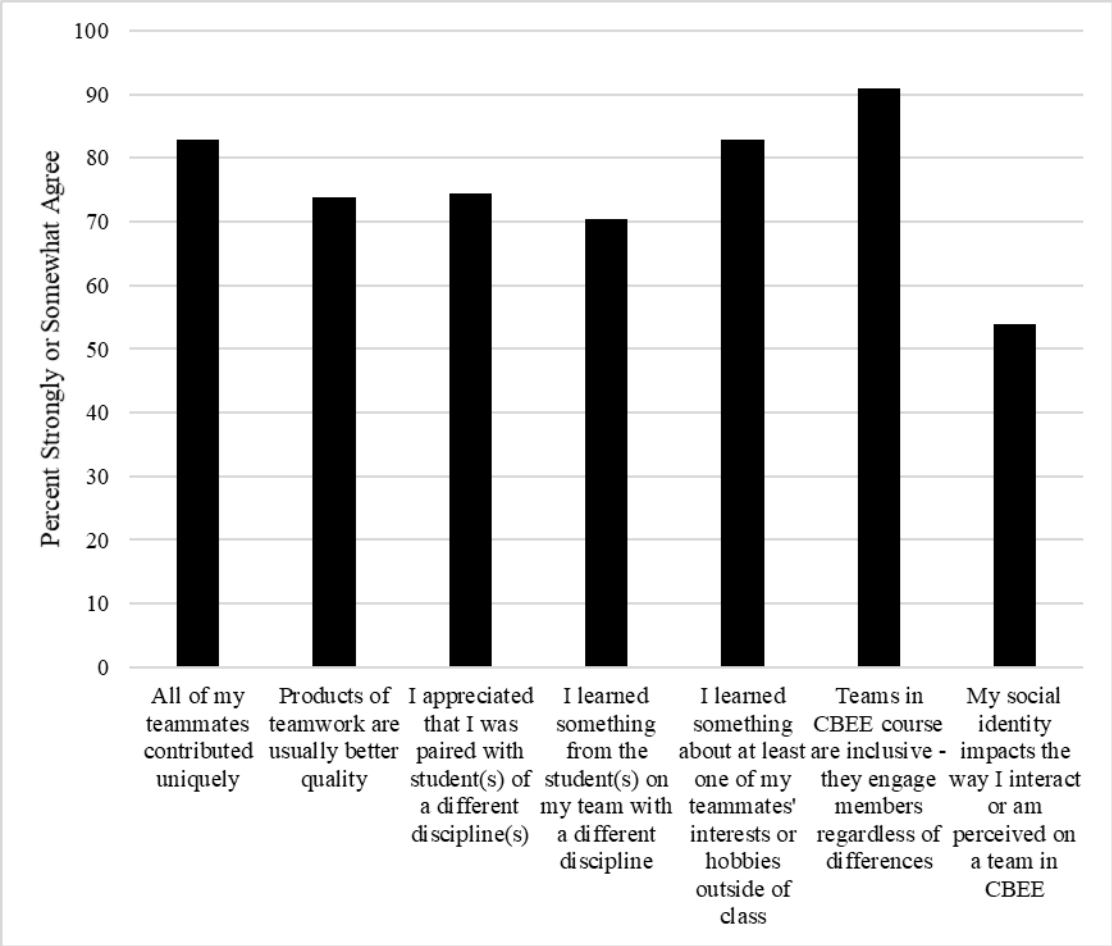

Figure 4. Percent of Fall 2017 survey respondents strongly or somewhat agreeing with Likert scale prompts about teamwork culture. The prompts were sometimes abbreviated; more details are in Table 2.

Conclusions

Efforts to incorporate effective training and teaching on teamwork skills, with a focus on inclusivity, have shown promise for advancing student behavior and perception. Ideally, the activities gave students opportunities to practice teamwork skills such as setting expectations and resolving conflict and moved their knowledge to the practice of knowing – applying the knowledge successfully in team situations. So far, survey responses indicated the students found the activities to be most helpful for the practice (knowing) of team formation/norming such as establishing expectations for communications and meetings versus knowledge (understanding concepts of team functionality, norms, etc.). However, improvements are still much needed for the students to see the impact of these practices on their team products. If progress continues, we will also see results in team projects and future career surveys.

Overall, some students report appreciation for the activities because they gave structure to discussing and alleviating some uncomfortable issues. The culture of teaming in CBEE is already perceived to be strongly inclusive, and we can use this culture to effectively spread teamwork expectations to all levels of the curriculum. Activities for setting team expectations at the time of team formation were well received by the students and imparted a positive impact throughout the

term. We will continue to use team contracts or resumes as initial team formation exercises with progress development of activities which build upon and reinforce teamwork fundamentals and skills for conflict resolution. Because working through conflict by giving constructive feedback to teammates was an area of weakness reported by the students, efforts are being made to give students tools to resolve conflict with their teammates and leverage that conflict to create stronger team products. Outcome assessment continues as does team activities development and revision.

As we gain more understanding and experience in piloting teamwork instruction, we are becoming better positioned to sort instructional content and skill development into a progressive framework (across course type and complexity) that will guide and hone students' teamwork competences. For example, it is clear that many foundational concepts need to be introduced during students' first-year (e.g., team norming, conflict management, effective team communication, and team roles). While this level of instruction is primarily knowledge based, students will gain a sense of teamwork knowing as they progress through extensive studio-based coursework during their middle years when concepts of team knowledge will be practiced. During these experiences, as well as senior-level laboratory and design sequences, learning tasks posed to students will slowly grow in complexity, requiring input from multiple students who possess varied experiential lenses and intellectual abilities for their completion.

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We would like to acknowledge awareness of other teaming efforts in our curriculum by instructors not part of this work or the Professional Learning Community and plan to incorporate and work with them as our project progresses.

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Appendix

Examples of Teamwork Activities (Formatting has been adjusted for brevity.)

Team Contract:

INTEROFFICE MEMORANDUM – EFFICIENT BIOETHANOL, LLC

TO:	EB PROCESS ENGINEERS
FROM:	CORPORATE STAFF DEVELOPMENT
SUBJECT:	TEAM CONTRACT
DATE:	SEPTEMBER 25, 2017

To promote high-functioning, successful teaming, EB, LLC encourages all teams to complete the following team contract prior to beginning work on team tasks. Please spend at least 15 minutes to normalize your team expectations.

TEAM CONTRACT

Mission

Norms

Goals

Performance Measurement

Use the following questions to guide your team contract formation. Sign the contract when complete.

Mission Statement: (What is the purpose of your team?)

Team Norms: (Code of Conduct)

What are some guidelines for how you want to interact during team meetings and work sessions (such as lab experimentation)?

Are there any performance or communication guidelines that should be adhered to?

How will decisions be made?

Team Goals:

What are your goals for your project? What do you hope the results of the project benefit?

Performance Measurement:

What standards will you use to determine if your team is performing satisfactorily? Are these related to your interactions as engineers and/or to the goals of your project?

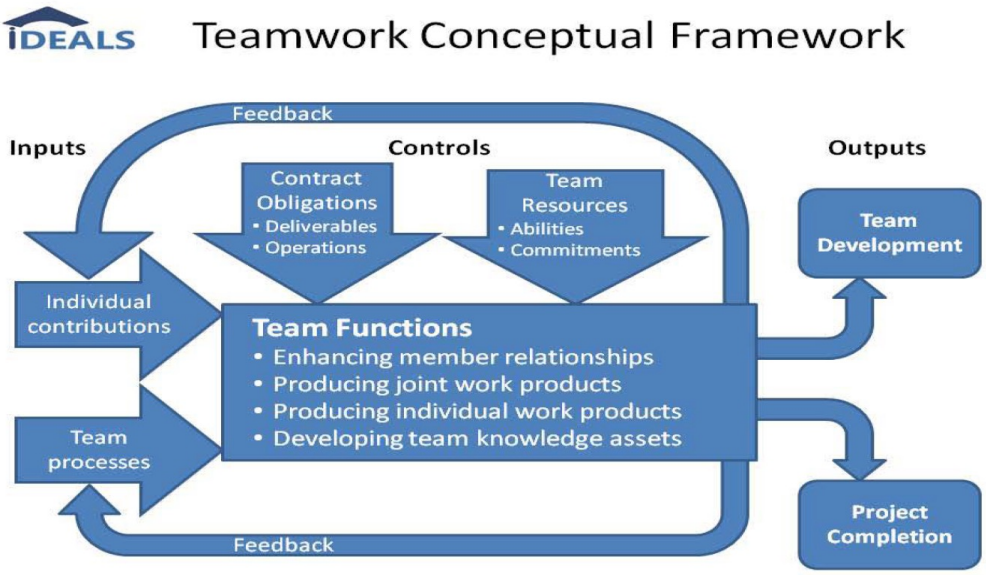
Team Member Signatures and Date:

Team Resume:

INTEROFFICE MEMORANDUM – KLA ENTERPRIZES

TO:	KLA ENTERPRIZES STAFF
FROM:	CORPORATE STAFF DEVELOPMENT
SUBJECT:	TEAM FORMING BEST PRACTICES
DATE:	SEPTEMBER 2, 2014

To promote high-functioning, successful teaming, KLA Enterprises encourages all teams within the corporation to review the following teaming conceptual framework and complete the recommended team forming activities after teams have been identified, but prior to beginning work on team tasks.



Initial Team Forming Best Practices

1. Individually consider the following questions. You may want to write some notes about your reflections on the questions. You will be sharing your thoughts with team members. (20 min)

    a. What are your motivations to fulfil the responsibilities on the team? Some people are highly motivated by relationships with other – do not want to let people down, want to be helpful, etc. Some folks are very motivated by obtaining a good grade, while other folks think more about learning than the final grade outcome. Some folks are motivated by impressing others with the knowledge and skills, while others are most interested in the work with the team to be organized, efficient, structured, and without conflict or drama. None of these is inherently better than the others, but communicating your motivations to your team members will help mutual understanding.

    b. What are your strongest skills and practices? Are you good at organizing? Quantitative calculations? Big picture understanding? Providing insightful questions? Including other team members and making them feel valued? Keeping the group on task? Reflect on your strengths.

    c. What are you most challenged by? Do you tend to procrastinate? Dominate discussions? Not participate in discussion because you are shy, embarrassed, unsure? Do

you have trouble speaking up in a group? Is conflict difficult for you? Do you jump to solutions too quickly? Do you have trouble staying on task? Do you tend to interrupt?

d. What teaming skill would you like to work on this term? Possibilities include clear communication, being inclusive, being open to alternative ways of thinking, staying of task, being more organized, celebrating your team member's achievements, staying calm during conflict, etc.

Share your reflections on the above questions with your team members.

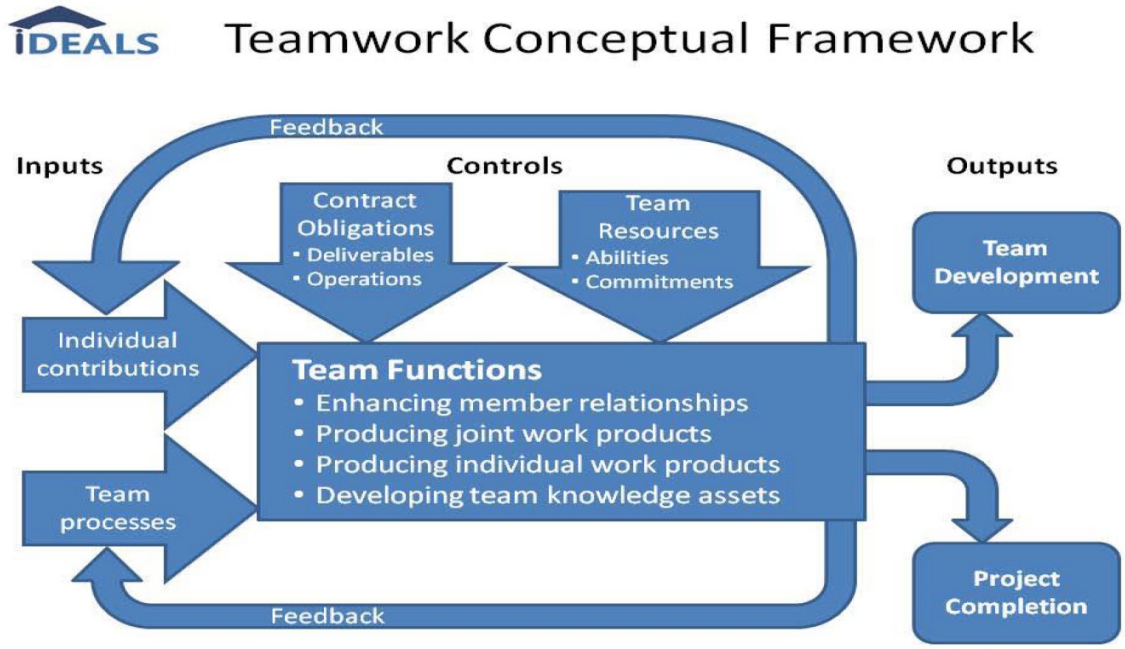
2. Discuss each team member's thoughts on what team behaviors would make CHE 443 studio an effective, inspiring, enjoyable, and stress free experience. Discuss each team member's fears or apprehensions about what might happen in this teaming environment (CHE 443 studio) that would be unpleasant. Suggest approaches to promote the effective behaviors identified, and suppress behaviors that might result in negative outcomes. Discuss how to recover if the negative outcomes do occur. (15 min)
3. Develop an informal team resume. The resume can include the following information about the team members: education, work experience, professional skills, special skills and talents, accomplishments and awards, hobbies and interests. Rather than make individual listings for each member, try to integrate and synthesize into a *team* resume – i.e. the collective work experience of the team. Give the hand written, informal resume to the studio TA. (20 min)

Mid-term Team Refinement:

INTEROFFICE MEMORANDUM – EFFICIENT BIOPRODUCTS, LLC

TO:	EB PROCESS ENGINEERS
FROM:	CORPORATE STAFF DEVELOPMENT
SUBJECT:	TEAM REFINEMENT - FEEDBACK
DATE:	OCTOBER 23, 2017

To promote high-functioning, successful teaming, EB, LLC encourages all teams within the corporation to review the following teaming conceptual framework and complete the recommended team refining activities.



This activity is focusing on the feedback loops. Recall that feedback should be structured (this activity) and constructive (positive). Teams must define performance definitions in order to assess their performance and give feedback appropriately. Teammates should first use self-reflection to have ownership of expectations and personal performance.

Self-reflection

4. Individually consider the following questions. You may want to circle those that apply or write some notes about your reflections on the questions.

    e. What are your motivations to fulfil the responsibilities of the team? Some example questions you can ask yourself: Do I want to: not let people down, be helpful, get a good grade, learn a lot, impress others with my knowledge and skills?

    f. What are your strongest skills and practices? Some examples are: organization, quantitative calculations, big picture understanding, insightful questioning, including others to make them feel valued, keeping the group on task. Reflect on your strengths and how your skills impact your team.

g. Which behaviors do you need to challenge yourself to improve upon? Examples: procrastination, dominating discussions, not participating in discussions, speaking up in a group, conflict avoidance, making conclusions too quickly, staying on task, interrupting others. Reflect on your challenges and how they may impact your team.

h. Reflect upon your interactions with your team thus far. Which practices for effective teamwork would you like to improve the remainder of this term? Examples include: listening to others, having a positive attitude about assigned work, clear communication, being open to alternative ways of thinking, staying on task, being more organized, encouraging and celebrating your team members' achievements, staying calm during conflict, etc.? Reflect on the areas to focus your attention.

Team Reflection

5. Reflect on behaviors you have noticed about others that are positive and have helped your team function well. List a positive thing about each of your teammates. When done, discuss as a team. Refrain from saying anything that you think others' may need to improve.

   a.

   b.

   c. (if fourth team member)

Performance Definitions

6. Review the Performance Measurement section of your Team Contract signed the first week of lab. Discuss as a team. Do you still agree with your list or would you suggest any changes? Note any changes below. List one way your team can improve its cohesiveness.

Survey instructions for results shown in Figure 2:

During CBEE414, there were two teamwork activities completed: 1. An initial team forming worksheet to discuss expectations and 2. During week 5, a check-in worksheet to think about how team functionality may be different during virtual lab activities.

With those activities in mind, please rank how you agree/disagree with the following statements:

(For example, choose "Neither" if you think the teamwork activities had no impact on your team functionality. Choose "Strongly Disagree" if you think the activities had a negative impact on your team functionality.)

Please be objective. If your team functioned well, think about how much the activities contributed. Or, if you team was dysfunctional, think about if it would have been more or less dysfunctional without the teamwork activities.

Table A1. Excerpt of Raw data from survey administered Fall 2017 in CBEE 414 with overlapping enrollment in CHE 443 and BIOE490. Total number of respondents = 177.

Prompt	**Percentage of survey respondents**				
Please rank the degree to which you agree/disagree with the following statements.	**Strongly Agree**	**Somewhat Agree**	**Neither**	**Somewhat Disagree**	**Strongly Disagree**
All of my teammates contributed uniquely to the team products (This does not mean equal quality or amount of contributions).	52	31	9	6	2
I think the products of teamwork are usually better quality than the products of work I complete individually.	38	35	16	7	3
(If you had a mix of disciplines on your team.) I appreciated that I was paired with student(s) of a different discipline(s).	42	32	22	3	1
(If you had a mix of disciplines on your team.) I learned something from the student(s) on my team with a different discipline.	38	32	24	3	3
I learned something about at least one of my teammates' interests or hobbies outside of class through the process of being on their team in CBEE414.	54	28	7	7	3
Teams in CBEE course are inclusive-they engage members regardless of differences (gender, identity, race, nationality, language).	68	23	7	2	1
My social identity impacts the way I interact or am perceived on a team in CBEE.	25	28	22	15	9