

Assessing Teamwork in Large Classes

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Abstract

Companies who hire our alumni frequently list teamwork skills as one of the most important attributes in new hires. The literature on flipped classes also highlights how important teamwork is for students learning new material: an effective team can help every level of student understanding from the A+ student to the barely-passing student. Many different faculty have developed peer evaluation forms for students working on teams to fill out, but in large enrollments these peer evaluation forms take too much faculty time to process. This paper presents the clicker-based peer evaluation used in Statics at NC State which allows the instructor to capture data rating every student at least once a week on their participation and preparation. Also included is the Teaching Teamwork material used with the final team project.

Keywords

flipped class, teamwork, large classes, clickers, Statics

Introduction

Ample literature shows that students learn well when they work with teams of their peers. Indeed teamwork is one of the driving ideas behind using a flipped class.¹ But teaching teamwork is not something that is done routinely in our curricula.^{2,3}

Some people have innate skills that help them lead and participate in teams easily. There is a similarity with swimming: some children take to swimming really easily while others have to be taught and never really master it. Since swimming is a useful skill, we tend to emphasize learning a bit of how to swim even with people for whom it is not “natural.” While we believe that working well on a team is also a useful skill, we do very little teaching about how to do it well. Basically we throw the students in the pool and expect them to figure out how to work well as a team with little instruction. And we do very little in the way of assessment of whether teams are good or bad. Even asking the question of whether your team worked well together is fraught: we do not have any agreement about what “worked well” actually entails.

This paper does not include a full review of the literature pertaining to teaching teamwork or motivating teams. A lot of really good research has looked into what makes a great team beyond what little referenced here including even comedy improvisation where team of comedians who can learn to build on their teammates has much to teach teams of students as well.⁴ Our goal in this paper was to share what we did that has been useful in Statics.

Statics in Mechanical and Aerospace Engineering at NC State is taught as a flipped class.^{5,6} Students are expected to work with their assigned teammates. Because Statics is fairly full of other topics, teaching teamwork has to be done around the margins.⁷⁻¹⁰ Assessing teamwork also

needs to be done quickly and easily in classrooms with more than 100 students. This paper describes the several ways that have been used in Statics to teach students how to work in a team, metaphorically how to swim.

The first issue with teaching teamwork is to specify what good teamwork looks like. Initial conversations resemble those around pornography: I don't know how to define it, but I know it when I see it.¹¹ And in most cases what we can see are failures in teamwork rather than successes.

We convened faculty panels with teachers from different departments to help codify what we wanted to teach. We distilled these many conversations into these learning objectives:

- Students should recognize what a good team looks like.
- Students should be aware of teamwork as a critical skill in today's workplace.
- Students should be able to enunciate project management skills sufficient to lead an initial team meeting.
- Students should be able to describe their own personality style and preferred working environment.
- Students should be able to compare and contrast teamwork assignments in one class to those in another finding unifying themes in teamwork across their experiences.
- Students should enunciate a hierarchy of principles for successful teamwork.

We recognize that our students have had bad experiences with teamwork. Often engineering students will remember that group project where they did all the work and shared the credit. Recognizing that it is difficult to motivate students to give teamwork another try, we enunciated these motivators for students:

What We Say To Students To Motivate Them

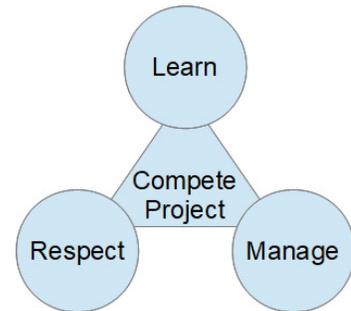
- You need to know this and be good at it by graduation even if it isn't currently a big part of your grade.
- Employers want good team leaders and followers; communication is essential in the workplace.
- Professionals work in teams. Recognize that no new employees get to pick their office space.
- Learn these skills and principles so that different classes/assignments don't all seem like new challenges.
- Teams can be hard: people don't do their work and don't communicate. But engineering classes are a different group of people than you've worked with before. Give it a chance.
- Making a difference is easier as a team than as an individual. Teamwork takes longer but can end up achieving more.

Why (Some) Students Listen

- Senior design is looming on the horizon for students.
- Students want to be qualified to get a job.
- Students want to be treated as grownups.
- Students always want easier classwork.
- We recognize that most students report prior team experiences that were awful.
- Some students really want to make a difference in the world.

We've defined a good team as one where students learn:

- the material for the course.
(Statics must remain the primary goal.)
- self-awareness, their strengths, weaknesses, and differences
- subjugation of ego to achieve larger results
(Even superstars need a good team.)
- how to work with people they don't like
(Diversity makes better products.)
- how to learn from failure.
(What makes a team experience awful?)
- how to motivate a teammate who holds different goals



At its root, good teamwork can be traced to respect for peers. Students must learn to follow, how to lead from behind. A good team experience will allow students to set realistic goals. It is crucial for underrepresented teams to learn to advocate for themselves in an environment which encourages them to do so.

In many respects teaching teamwork in Statics is a work in progress. Assessing these learning objectives becomes quite difficult in the middle of an engineering class. This paper includes some of the ways to add teaching teamwork into Statics.

Team Formation

Students work in two different kinds of teams during Statics. The first and most omnipresent is their team assignments for the in-class work. These teams are assigned by the professor. Teams are switched up after each of the three midterms so each student works with 7 or 8 other students over the semester. The second kind of team is a student-chosen team of 2-4 students for the final bridge project.

Each in-class team has three people on it. Roles are introduced at the beginning of the semester and rotate every day: a recorder, a manager, and a skeptic. The recorder has the only white-board marker for the team and is encouraged NOT to use a calculator. The manager is to keep the team on task and moving. The skeptic's role is to ask why that is the right step. Managers and skeptics use the calculators for the team. Each day the first slide lists some arbitrary way of choosing the roles: for example, the manager is the one who got here first, the recorder is the one of the others who lives farthest away, and the skeptic is the third student. Over the course of the semester, the teams that choose their daily roles using these see them as ice-breakers. The other teams just take turns being recorder and ignore the rest.

The final project is completed in student-chosen teams. It is common for the project teams to include pairs of students from in-class teams which suggests that students are forming connections to other students from their in-class assignments. The 121 project teams from Fall 2017 included pairs of students from the first in-class team assignment 24 times, from the second assignment 16 times, from the third assignment 27 times, and from the fourth assignment 16 times. Students seem to use in-class teams to find project teammates.

In-Class Team Assessment

Assessing team functioning is difficult in a classroom with 123 students, but the clickers used in the classroom presented an opportunity to evaluate the in-class teams. Each student is assigned a team and within that team is given a symbol, for example ♠, ♣, or ♦. So each student is uniquely identified. At the end of each class, I ask students to evaluate the person on their team with one of the symbols. Each student is evaluated by his peers one out of every third class.

Initially the evaluation questions ended up with each student getting and giving higher and higher rankings. The questions were tinkered with until student responses seemed to give reasonable peer rankings. The current question being used every day is:

For the person on your team with the spade ♠ on his/her nametag (including yourself), was she/he helpful, prepared, and involved in your teamwork today?

- A) Absent (or as good as absent)*
- B) He/she was here and did what was asked. Perfectly fine.*
- C) One of the best*
- D) Far and away the best student on our team (rare)*

The choice of “Absent or as good as absent” always makes some of the students laugh, but it also allows them to report students who are really not pulling their weight in coming to class prepared to work on the in-class assignments. The single peer evaluation question is posted at the very end as students are packing up so it takes no class time.

After each midterm students can see the evaluations they've received from their teammates and from themselves. A mismatch between how they view themselves and how their teammates view them can be very informative for a student as a team member. It is important to note that this question does capture the students who are not participating and the very best students but does not indicate any fine-tuning. Also, the scores the students give themselves and their teammates are not correlated with their success in the class: the correlation coefficient between the number of D's recorded as being the best student on the team versus the final grade in the class was -0.07 indicating that the two are not correlated.

These rankings are not used in determining student grades, but the rankings are useful in identifying who is participating in the team and who is missing or useless in the teams. A student who received BDDDDAA from her teammates missed one class day but was otherwise very helpful on the team. A student who received ABAAABAA from their teammates was clearly not.

This way of scoring teamwork during class allows for semi-automated identification of people who are not pulling their weight. Statics also includes one-question quizzes at the beginning of the class period to encourage people to do the prep work before they come to class. Combining the quiz grades and the teamwork evaluations allows identification of students who are chronically coming to class unprepared or not coming to class at all. Once those students are identified they can be approached to see if there is something amiss or if they need one-on-one encouragement to step up their efforts.

Project-Team Assessment

Project teams are encouraged to use the First Meeting Agenda which is included in Appendix I. This agenda captures several of the learning objectives listed above. The project teams are assessed using the team contract shown in Appendix II. The team contract is required in the student final project submissions.

The first semester this teamwork contract was offered it was not required. We surveyed the students to see if they found it useful.

If you used the teamwork agreement, why?

- Thought it was helpful (N = 63, 24%)
- Thought it was required (N = 27, 10%)
- Better than writing something (N = 122, 47%)
- Other (N = 8, 3%)
- Didn't use teamwork agreement (N = 41, 16%)

Do you think you would use such a teamwork agreement in the future?

- Yes, probably – seems useful (N = 92, 35%)
- It could happen (N = 147, 55%)
- Probably not – don't see the benefit (N = 23, 9%)
- Prefer not to answer (N = 3, 1%)

Were you in a group that was helped by having filled out the contract?

- Yes (N = 36, 14%)
- Sort of (N = 111, 42%)
- No (N = 115, 44%)

We expected that students who were in short-term, self-chosen teams would not use the teamwork agreement when it was optional. And yet more than half of the students were able to say that it had helped them at least a little. Ninety percent of the students thought that such a teamwork agreement might be useful in the future.

Future Work

The team formation used here can be improved upon. CATME is an online, research-based team management software which could allow teams to be formed using much more detailed student surveys, a superior way to make the teams. Such an online system suffers from the response-rate issues which should be worked around in some fashion. Future work will also include moving from the TurningPoint clickers used in this study to TopHat which is an online and phone system of gathering student response data.

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Appendix I: First Meeting Agenda

There is a difference between working as a team and functioning as a team. Take a few minutes at your first meeting to go through this agenda. Set someone to take notes from the beginning. Use the team contract provided if desired.

Introductions:

These first questions should be answered by everyone. These are questions to individuals and may differ between teammates. Use this time to listen respectfully to your teammates (even if you're old buddies). Try not to assume you know the answers others might give.

1. Introductions (name, major, etc)
 - a) State your name and major.
 - b) Optional: tell one crazy thing about yourself which the others might not know.
2. Individual motivation
 - a) What motivates each of you to put forth your greatest effort?
 - b) (Grades? Competition? Approval? Completion?)
3. Individual goals for the project
 - a) What grade does each person want?
 - b) How much does learning something matter to each person? Is getting a good grade enough? Do you want a broad understanding beyond the scope of the project? Somewhere in between?
4. Time willing to commit
 - a) How much time are you willing to spend?
 - b) If things don't go as planned, would you rather take a lower grade or work late into the night?
5. Time restrictions
 - a) Are there times you are unavailable to work on the project?
 - b) Are there other demands on your time which might impact the project?
6. Strengths and weaknesses
 - a) What are your strengths? What are your weaknesses?
 - b) How can each of you contribute best? (Be honest here.)
7. Contact preferences
 - a) What are your first and second choices for getting in contact with each other?
 - b) What are your expectations for response time?
8. Concerns
 - a) What is your greatest concern about team work?
 - b) What are the best and worst experiences you've had with team work?

Team Goals:

Now, take the answers you gave as individuals above, and discuss team goals for project. Finalize team goal(s) to which everyone can agree. Note: finishing the team goals does not finish the first meeting! It is important to continue to discuss how you will meet those goals.

Team Workings:

Once these items have been discussed with every team member contributing and listening, the team should decide on the logistics for the project. As you answer these questions, keep these things in mind:

1. Documentation (Document everything, even for a small project!)
 - a) Who will act as scribe?
 - b) Where will these documents be kept?
 - c) How will items be shared?
2. Scheduling and task planning
 - a) How will the team communicate?
 - b) Agree on a method and response time expectation.
3. Contingency plans (Answers to these questions will evolve, but it's best to have them out in the open before beginning a team project.)
 - a) How will you handle a change in team membership?
 - b) How will you handle it if a member needs to change his commitments?
 - c) What happens when a team member is going to be late or absent from a team meeting?
 - d) What should a team member do if he/she becomes frustrated with another member? How will the team handle a member who wants to do nothing? or who wants to do it all?
 - e) What happens when a team member hasn't met his commitment and the deadline is approaching?
 - f) Were there other failures mentioned above that you need to make a contingency plan for?

Project Logistics:

Now that you've discussed the above, you can discuss the specific assigned project. (Too many teams skip the discussions above and only discuss the project; this leads to many misunderstandings which could have been avoided.)

- What will be required in completing the project?
- Roles - who will do what?

Team Contract:

Complete and sign a team contract. A sample is provided here [Project Team Contract](#).

Scheduling

Schedule the next team meeting.

Action Items

Take a moment before you leave to review the action items for each team member. Include who is doing what, when, and how you will follow up. Make sure that someone is documenting action items in a way that everyone can view them.

Appendix II: Team Contract

Team Contract: [class and section] _____ Project title: _____

Project team individual answers:

Introductions:	Name	Name	Name
Individual motivation			
Individual goals			
Time willing to commit			
Time restrictions			
Strengths and weaknesses			
Contact preferences			
Greatest concern			

Team goal(s) for this project: (list 3)

1. _____ 2. _____ 3. _____

Team Agreements:

All discussions and decisions to be documented by _____.
 Documents will be kept and shared at _____.
 Primary method of communication: _____.
 Expected response time: _____.
 If team member becomes unresponsive, _____.
 If a team member needs to change his responsibilities, _____.
 If team member becomes frustrated, _____.
 If a task is not completed on time, _____.
 [Other agreement] _____.

Project Needs / Team Member Roles and Responsibilities:

Specifically, who is going to do what on this project?

Team Member:	Roles/Responsibilities

Sign below to show your agreement with this contract: