

Microsoft Teams Utilization for Group Function in Maritime-Focused Mechanical Design Capstone

Dr. Robert Kidd, State University of New York Maritime College

Dr. Kidd completed his B.S., M.S. and Ph.D. at the University of Florida in 2011, 2013, and 2015 respectively. He worked at the Center for Intelligent Machines and Robotics at UF from 2009 to 2015 researching the use autonomous ground vehicles including ATVs, a Toyota Highlander, and a tracked loader. He has taught at SUNY Maritime College since 2015 running the capstone design sequence for mechanical engineers. His research interests include additive manufacturing, fault-tolerant control, artificial immune systems, and autonomous ground vehicles and surface vessels.

Microsoft Teams Utilization for Group Function in Maritime-Focused Capstone Mechanical Design

Abstract

Evaluating the ability of students to do group work or function effectively on a team has always been a challenge. This was especially true with the transition to online learning that occurred during the pandemic in early 2020. This challenged not only the ability of the students to complete their group assignments, but also the ability of the instructors to perform ABET assessments on the ability of students to function on a team. To mitigate these issues, Microsoft Teams was implemented as a collaboration platform and a tool for additional assessments. This paper details the implementation strategy in a capstone design course and the results from Fall 2020. Results demonstrate that significant benefits can be generated in both group functionality and group interactions by incorporating Microsoft Teams.

Course Background

The capstone design course for Mechanical Engineering at SUNY Maritime College is a 2-semester sequence where students design, build, and test solutions to maritime problems from a mechanical perspective. The sequence is offered once per year, so all students start together in the Fall semester and end in the Spring semester before graduation. For the 2018-2019 academic year, the students were tasked with developing a robotic system that could be used to clean up the East River around campus. Full-scale designs were tested at the end of Spring 2019. In 2019-2020, the students were tasked with creating a near-shore platform for wave attenuation to prevent erosion while also performing wave energy harvesting. Scale model testing was scheduled to be performed in Spring 2020. This plan had to be scrapped when classes went remote, with increased emphasis being placed on an accompanying written design report. The task given to the 2020-2021 students was to create a device that would increase efficiency at a port by allowing multiple shipping containers to be moved in one action or allow shipping containers to self-stack. Scale model testing was scheduled to be performed in Spring 2021.

Because the design work during the sequence is so broad, several ABET assessments are performed in the two courses. This paper focuses on ABET Criterion 3 Student Outcome 5 (henceforth ABET Outcome 5). The ABET Outcome 5 is given as “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” [1]. This outcome is broken down into 6 categories – or performance indicators. Utilizing these performance indicators allows an identification of what portions of the outcome students are struggling to meet. The breakdown is discussed in the Assessment Methods section of this paper.

For all of the projects in the sequence, there is a heavy component of background research and coordination that must be performed before designs are finalized at the end of the Fall semester followed by prototyping and testing in the Spring semester. The complex nature of the maritime environment means that beyond the typical research into existing solutions, the students must do additional research to find out the constraints for their projects. For example, the waterfront

cleaning robot in 2018-2019 needed to filter out garbage of the correct size based on what common garbage is found in the water. At the same time, it needed to be powerful enough to move the filtration system to overcome local currents and tides. The projects must also abide by all local and national regulations. In 2020-2021, for example, this meant research into Occupational Health and Safety Administration (OSHA) regulations on shipping container design and on manipulation of shipping containers in ports. All of this research is interrelated and must be brought together coherently if final designs are to work. This makes the Fall semester an excellent opportunity to analyze how well these students work as a team on design work.

The Spring semester is used to analyze how well these students work when they transition to physically realizing their design. This phase usually draws out any underlying friction between group members because it is plainly obvious when students generate shoddy work or do not complete their assigned tasks. This highlights their ability – or, frequently, their inability – to work through conflict. Thus, data from both semesters can be utilized for assessments of ABET Outcome 5.

Assessment Methods

Starting in Spring 2019, students in the sequence were required to fill out a 20-question Likert survey at the end of every semester regarding their perception of how effectively the team functioned. The survey is the primary method of assessment for ABET Outcome 5 with additional observations made from the instructor added as necessary. The Team Health Assessment developed by David Ullman served as the basis for this survey [2]. Each question is presented a statement and asked whether the student agreed that the statement accurately reflected their group. The questions in the survey are mapped to 6 categories – or performance indicators – of ABET Outcome 5. Response options are: strongly disagree, disagree, neutral, agree, strongly agree, and not applicable. The questions are formulated such that members of a well-functioning group will strongly agree with all statements. Any not applicable selections were omitted. A strongly disagree or disagree selection is mapped to poor performance on the corresponding performance indicator. Neutral, agree, and strongly agree selections are mapped to adequate, good, and excellent performance on the corresponding performance indicator. The performance indicators and the question mapping are given in Table 1 below.

Performance Indicator	Description of Performance Indicator	Survey Questions
5.a	An ability to provide team leadership	5, 6, 12
5.b	An ability to create a collaborative environment	2, 5, 7, 8, 11
5.c	An ability to create an inclusive environment	4, 9, 10, 16
5.d	An ability to establish team goals	1, 18, 19
5.e	An ability to plan team tasks	6, 17, 20
5.f	An ability to meet team objectives	3, 13, 14, 15

Table 1 – Definition of performance indicators for ABET Outcome 5 and corresponding questions in the end of semester survey

Implementation with Microsoft Teams

While this project and assessment setup had been successful, the inability to meet in-person was a drastic change for our students in Spring 2020. Over 75% of them live on campus and are accustomed to being able to meet in-person whenever necessary. Few students effectively met the challenge of working in groups remotely, exposing a large gap in the program. Of 7 groups that semester, only 2 completed their projects satisfactorily and several groups fell into major conflicts that were never resolved. The final ABET Outcome 5 assessment could not be performed since so few projects were completed. This chaotic situation indicated that the mechanics of groupwork needed to be improved going forward.

To address this, and in anticipation of a similar scenario playing out in Fall 2020, Microsoft Teams was utilized for the 2020-2021 sequence. Students are traditionally allowed to pick their own groups and do all group management, task assignment, planning, etc. as they see fit. The only requirements are that they provide a weekly memo detailing the work done the past week and the plan for the next week. After the students selected their groups in Fall 2020, each group was given a private area within Teams that included videoconferencing, chat functions, file sharing, and a Microsoft Planner for task scheduling. The students were shown a short video tutorial of these features and directed toward resources they could use to get additional utility out of them. The goal for this implementation was to encourage the students to become familiar with the online collaboration tools on their own in anticipation of a return to remote learning at some point in the semester. The students were told that the class would use the features of Teams when classes went remote, such as weekly status meetings with the instructor, but no points were assigned to this in the class. The ABET assessment survey was embedded in Teams through Microsoft Forms.

This allowed each group to adopt Teams as best suited their needs instead of a uniform approach across the class. Since groups are able to tailor their area, it was anticipated that this would result in a slight increase in the performance indicators related to establishing goals and planning tasks, with a follow-on effect of meeting more of their goals. No other substantial improvements were expected. The campus was able to allow in-person instruction for all but the last 2.5 weeks of classes. This meant that the students were able to work on the majority of their groupwork in-person while still using Teams. It was anticipated that this would lead to no significant decreases in performance relative to previous semesters in any category.

Data was not tracked to compare students who utilized Teams extensively with those who did not. Some groups were more comfortable utilizing alternative collaboration tools such as Google Suite or Google Workspace. This was allowed to encourage the students to develop whatever system worked best for them.

Analysis of Effectiveness with Teams

Due to the size of the institution, no control group was able to be used. Instead, historical data from previous semesters coupled with summary results from across the department were used to evaluate the effectiveness of Teams. The assessment results from previous semester surveys are

given in Tables 2 and 3 to provide baseline performances. A direct comparison can be made between Fall 2020 and Fall 2019 as the teams have been working together for approximately the same amount of time and are given the same tasks of background research and preliminary design work. Data for Spring 2019 is not a direct comparison since the Spring students had been together much longer and had been working on tasks related to prototyping and testing. The number of students in a given semester (n) is small due to the size of the institution, but represents one cohort of students

Performance Indicator	Poor	Adequate	Good	Excellent
5.a) Leadership	10%	16%	40%	35%
5.b) Collaborative Environment	8%	19%	36%	37%
5.c) Inclusive Environment	17%	18%	32%	34%
5.d) Establish Team Goals	12%	11%	47%	31%
5.e) Plan Team Tasks	11%	7%	42%	40%
5.f) Meet Team Objectives	15%	13%	34%	38%

Table 2 – Teamwork performance indicators for Spring 2019 (n=27) with percentage of responses that rate their group behavior as poor, adequate, good, or excellent

Performance Indicator	Poor	Adequate	Good	Excellent
5.a) Leadership	14%	7%	48%	30%
5.b) Collaborative Environment	10%	11%	48%	32%
5.c) Inclusive Environment	17%	12%	39%	32%
5.d) Establish Team Goals	9%	17%	47%	28%
5.e) Plan Team Tasks	9%	9%	65%	18%
5.f) Meet Team Objectives	20%	11%	49%	20%

Table 3 – Teamwork performance indicators for Fall 2019 (n=19) with percentage of responses that rate their group behavior as poor, adequate, good, or excellent

These results are representative of assessment results done during the sequence in semesters before the survey method was used. Results are usually in the low teens for poor function and in the high teens for adequate function. It is not uncommon for ratings in Spring semesters to indicate students feel the team environment is less collaborative and inclusive (5.b and 5.c) but more able to establish goals, plan tasks, and meet objectives (5.d to 5.f). Research has shown that as students work together, their performance will increase while self-assessment ratings will tend to decrease [3].

While the above allows a comparison to be made to previous semesters, the data from courses outside of the Mechanical Engineering capstone sequence must be considered to ensure that the pandemic environment in Fall 2020 did not affect the data. Other methodologies are used for the ABET Outcome 5 assessments in these courses and not all majors within the department utilize the same performance indicators. This means that while the data from other courses can be used to give a general sense of whether the campus environment has changed, it cannot be directly correlated to the data from the survey. With that caveat, data from other courses indicate that behavior in Fall 2020 across campus showed no significant change. Some courses showed a

modest improvement while others showed a modest decrease. No courses indicated a major shift toward more or less effective teams. This suggests that the groups are able to prepare for or adjust to the last two and a half weeks of remote instruction department-wide.

With the expected performance defined, the Fall 2020 data can be analyzed. The data is shown in Table 4 and reflect significantly better results across all performance indicators.

Performance Indicator	Poor	Adequate	Good	Excellent
5.a) Leadership	2%	7%	37%	55%
5.b) Collaborative Environment	1%	5%	31%	63%
5.c) Inclusive Environment	3%	3%	26%	69%
5.d) Establish Team Goals	3%	14%	41%	42%
5.e) Plan Team Tasks	2%	8%	43%	47%
5.f) Meet Team Objectives	5%	5%	35%	54%

Table 4 – Teamwork performance indicators for Fall 2020 (n=23) with percentage of responses that rate their group behavior as poor, adequate, good, or excellent

Figure 1 provides a graphical representation of the survey results for each indicator over the past 3 semesters. Each bar represents all responses for a given performance indicator with the colors separating the percentage of responses that were poor, adequate, good, and excellent.

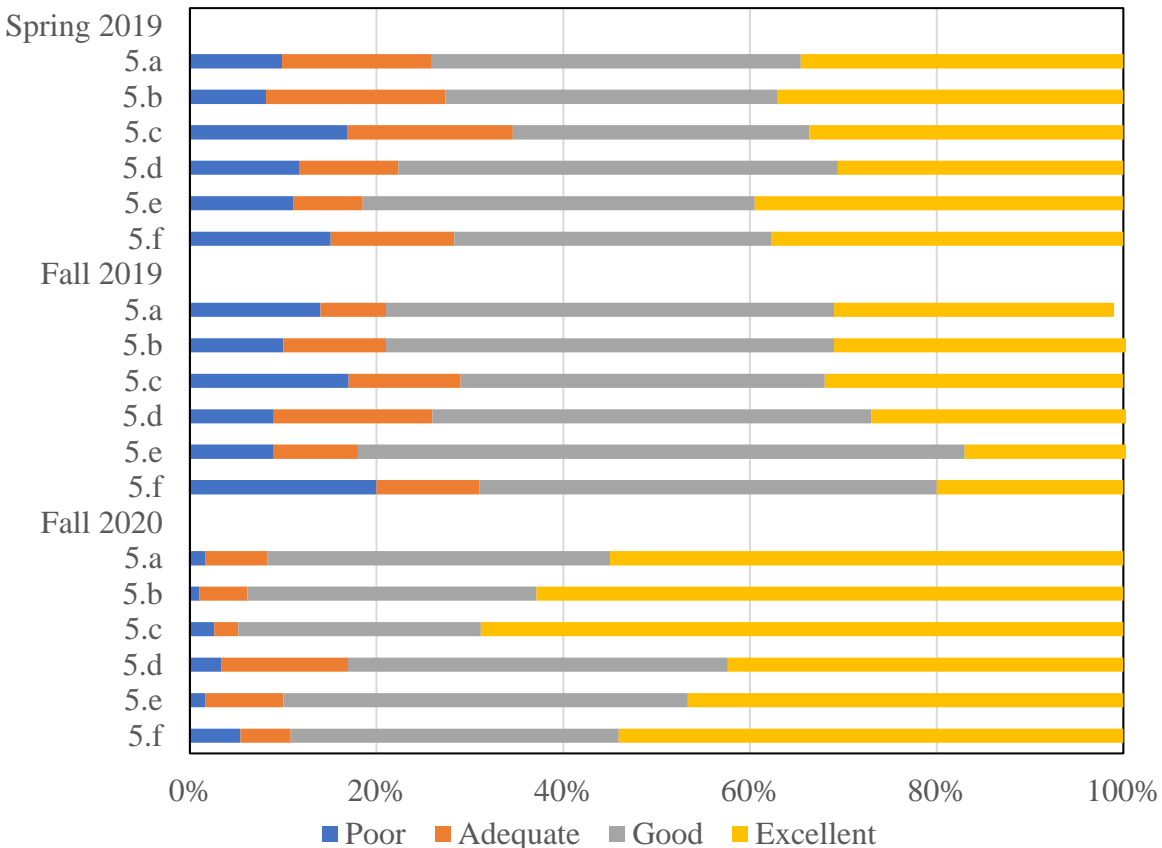


Figure 1 – Self-assessments broken out by performance indicator for Spring 2019 to Fall 2020

Two major shifts are noteworthy. First, the poor responses are nearly eliminated, with none over 5%. Secondly, the number of excellent responses were greatly improved. While no performance indicator had excellent responses exceeded 40% in either previous semester, all performance indicators had excellent responses greater than 40% in Fall 2020. In 3 categories – 5.c, 5.e, and 5.f – the percentage of excellent responses are more than double that of Fall 2019.

To compare the overall improvement in undesirable responses, the percentage of responses that indicated the group behavior was poor or adequate were added together. These are considered negative perceptions of the group as they indicate the students did not agree with the statements. These totals are presented in Table 5. Figure 2 looks at the semester trends of negative responses within each performance indicator.

Performance Indicator	S2019	F2019	F2020
5.a) Leadership	26%	21%	7%
5.b) Collaborative Environment	27%	21%	4%
5.c) Inclusive Environment	35%	29%	4%
5.d) Establish Team Goals	22%	26%	15%
5.e) Plan Team Tasks	19%	18%	11%
5.f) Meet Team Objectives	28%	31%	10%

Table 5 – Total negative ratings for the performance indicators after Spring 2019 to Fall 2020

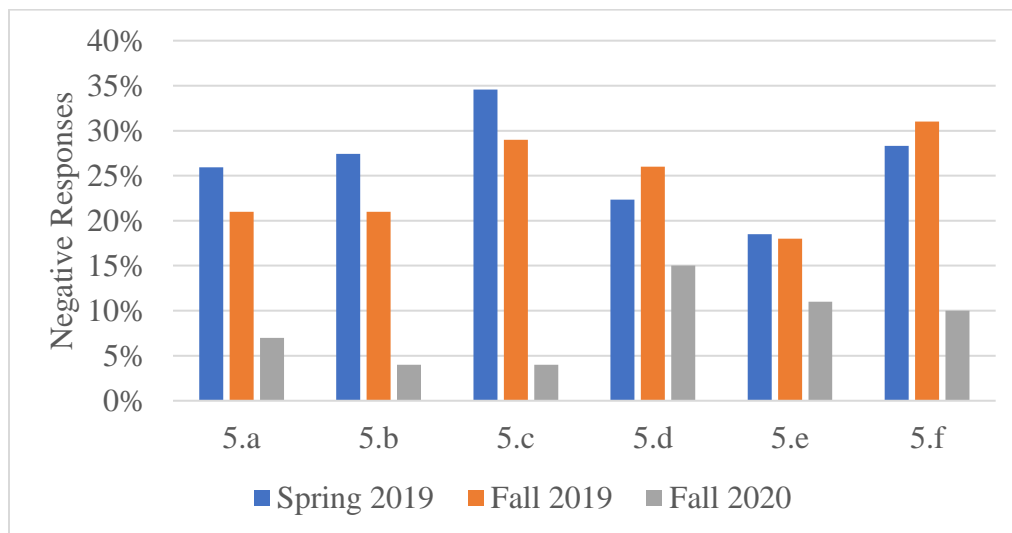


Figure 2 – Total negative ratings for the performance indicators after Spring 2019 to Fall 2020

As can be seen, the ratings for 5.d and 5.e are significantly improved, with approximately a 35% to 45% reduction in negative ratings compared to Fall 2019. The performance indicators 5.a, 5.b, and 5.f show large improvements of approximately 60% to 70%. Finally, 5.c shows a very large reduction of 82%. When comparing the data to Spring 2019, the improvements in 5.d to 5.f are generally smaller but improvements in 5.a, 5.b, and 5.c are greater.

As previously stated, the improvement to overall group function for indicators relating to establishing goals, planning tasks, and meeting objectives was anticipated. No improvement in provide leadership or create a collaborative and inclusive environment was expected, much less an enormous improvement as seen in the data. Utilizing these tools added a simple means to show students they could work together smoothly when they went remote ended up having significant positive effects on the groups, even when most of the work is done in-person.

There is naturally concern that the data is affected by the pandemic in some manner, that there is a sense of comradery and that the students felt “we’re in this together”. While this cannot be discounted entirely, this level of improvement was not seen in other capstone design courses. As previously stated, self-assessment results from other courses did not show any significant change.

In addition to the data above, the overall atmosphere of the course was improved. By allowing students to explore Teams and customize their setup, students were enabled to find new ways to leverage these tools. For example, some groups used Teams to help when their members were in quarantine. Students in the class inevitably tested positive or were close contacts with others who tested positive and had to go into quarantine. This meant that they were unable to physically participate during in-person lab activities. Instead of leaving these quarantined students to catch up when they returned, groups figured out how to use the videoconferencing function within Teams to bring them to labs as a telepresence. During the stress of senior year with an ongoing pandemic, seeing a group member carry a telepresence to check out some equipment in the lab was a welcome moment of inclusivity and levity.

It should be noted that while these assessments showed improvement, no clear performance change could be seen in the student work product. There are too many external factors to make a conclusion from work products during the pandemic affected semester and a normal semester. These factors include but are not limited to students choosing an asynchronous remote option for the lecture section, an overall downward trend in performance noticed across the department, and the increased stresses of an ongoing pandemic.

Conclusion

Introducing students to modern remote work collaboration tools via Microsoft Teams improved the self-assessments of the group behavior. The students reported a reduction in the number of negative responses and an increase in very positive responses across all performance indicators that are used for assessments of ABET Criterion 3 Student Outcome 5. These improvements were largest in the areas of group culture, such as leadership, collaboration, and inclusivity. Future work will be required to determine if these results are repeatable in future semesters and whether increased engagement with Teams will result in increased benefits.

Acknowledgements

The author would like to thank David Ullman for his design resources, especially the Team Health Template which was used as the basis for the assessment survey used. Additionally, this

work would not be complete without the support of colleagues within the Engineering Department who provided summaries of their assessment results to get department-wide comparisons.

References

- [1] ABET Engineering Accreditation Commission, "Criteria for Accrediting Engineering Programs Effective for Reviews during the 2021-2022 Accreditation Cycle," 2021. [Online]. Available: <https://www.abet.org/wp-content/uploads/2021/02/E001-21-22-EAC-Criteria.pdf>. [Accessed 6th February 2021].
- [2] D. Ullman, "Team Health Template," 2018. [Online]. Available: <https://bit.ly/3jKy0Pi>. [Accessed 12 February 2021].
- [3] Y. Cheng and P. Brickman, "When Group Work Doesn't Work: Insights from Students," *CBE - Life Sciences Education*, vol. 17, no. 3, p. AR52, 2018.