Capstone Design CONFERENCE 2024
JUNE 3–5, 2024 ▸ KNOXVILLE, TENNESSEE

Evaluation of Team Mentoring in a Large Capstone Course

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It is a challenge for instructors of large engineering capstone cohorts to provide adequate mentorship to a large number of teams. To provide each team with the support that they need, we assign a Team Mentor (TM) that meets the team weekly to guide them and to provide support as the project progresses. These mentors can be divided into five distinct groups – the instructors themselves, tenured/tenure-track faculty, non-tenure track (teaching) faculty, graduate student/post-doctoral researchers, and external engineers. Each team member evaluates their TM at the end of each semester of the two-semester project. A total of 2637 individual evaluations across 285 projects in 11 separate capstone cohorts were completed, and that data is presented in this paper. Overall the TMs rate very highly, with minor differences between the TM source groups. The authors have created a training program to help TMs acclimate to the role, and all TMs (even experienced ones) are required to attend. We believe that this training has been beneficial in helping the TMs hit the ground running with their teams, and with feedback and improvement over time, the training has kept evaluations scores high.

Keywords: Team Mentor, Capstone, Evaluation, Survey

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Introduction and Background

At the University of Texas at Dallas (UTD), all engineering students are required to complete a two-semester capstone project (senior design) course. As instructors for separate Biomedical and Mechanical Engineering courses, we were routinely exchanging students to create multidisciplinary teams that had the skills required to be successful. Eight years ago we decided to merge the two courses into one multidisciplinary capstone course and co-teach it together. The benefits of a multidisciplinary capstone experience have been studied and proven by many authors[1].

From the beginning, we worked to provide students with a "real-world" engineering project experience[2] in an industry-like environment. To support these aims, we structure the course as a consulting firm with the instructors as management and the students as working engineers. The vast majority of projects are sponsored by external companies, which further enhances the real-world feeling of our course. A few projects come from within the university and these are structured and treated the same as external projects.

Our "consulting" firm, UTDesign, has a corporate-style structure to help the students begin the transition from undergraduate student to working engineer. This structure is shown in the organizational chart in Figure 1. The course instructors serve as the Engineering Directors, with responsibility for the management of the overall "company".

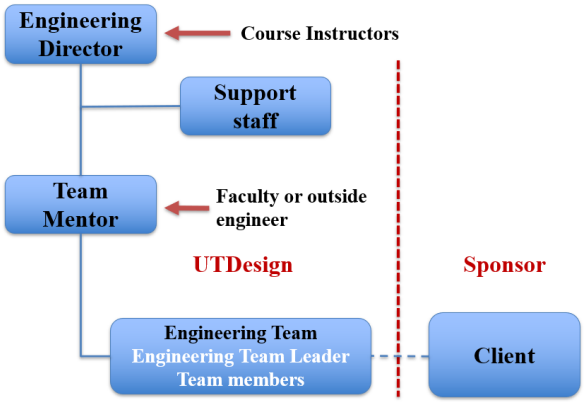

Figure 1: UTDesign structure.

UTD has grown rapidly over the last ten years with this growth paralleled in the engineering school. It is common for us to have 50-60 teams per year, each consisting of five to six students. This growth has created management challenges[3] for the instructors. It is not feasible for the two of us to properly oversee and mentor this many teams and be confident of their success.

This is where the second layer of "management" comes in – the Team Mentor (TM). The TM meets weekly with the team to guide, coach, mentor and review the team's progress. Meetings are expected to be in person, with virtual meetings held only sparingly. While the team is ultimately responsible for the planning, execution, and success of their project, the TM is there every step of the way to help the team stay on track and make progress toward successful project completion.

Team Mentors are also expected to review drafts of major deliverables and do practice runs of key presentations to help students understand how to craft good reports and presentations.

Periodic evaluations are used to provide feedback to both students and TMs with the goal of helping each to improve in their respective roles. TMs evaluate their team four times during the two-semester project (mid-point and end of each semester). With the exception of the first evaluation, these appraisals include individualized private feedback for each team member. Similarly, each team evaluates their TM twice (at the end of each semester).

The TMs come from five sources: the instructors, tenured/tenure-track faculty, non-tenure track (teaching) faculty, graduate student/post-doctoral researchers, and external engineers. The latter category includes retired and practicing engineers, some of which are former students. The level of experience of a TM in any group varies. The typical time commitment for a TM is an average of one to two hours each week per team. Most TMs work with a single team, with a few advising two or more teams. TMs are provided a stipend for their work.

Drawing on these five sources of TMs has provided us with a large enough pool of candidates to fill the 50-60 openings that we have per year. We have found that each of these groups brings unique strengths to the TM position. Involving external engineers has proven to be a great way to build industry/external relationships and to keep alumni connected with the university. In fact, we have had a number of external engineers that have enjoyed the experience so much that they referred their friends and colleagues to us.

At the beginning of each cohort, we reach out to prospective TMs, and, to the extent possible, try to find individuals with expertise and interests that match with the project topics. All TMs serve by choice since we do not have a policy that requires faculty to be mentors. Within the first few weeks of starting a new round of projects, the TMs are required to attend a training session led by the instructors. This training is required even if an individual has served in the role previously. The training covers the following: expectations and limitations of the TM role, structure and content of weekly meetings with their team, periodic performance evaluations of the team and the individual team members, reviewing purchase requisitions, and review of written deliverables. As the project unfolds, periodic emails are sent to TMs to share reminders and provide updates on key dates, deliverable expectations, and other critical information.

The objective of this research project was to determine if there were any differences in how TMs from these five distinct groups worked with their teams. This analysis made use of data obtained from the previously mentioned TM evaluations completed by students at the end of each semester. Our intention was not to use the results to say that one group is necessarily preferred as TMs over another. Rather, the goal was to identify areas where our TM training and procedures could be enhanced to improve the experience for all students on our capstone teams.

Evaluation Methodology

The evaluation of the TM consists of ten questions:

1. Our TM monitored our progress and offered feedback on our project schedule
2. Our TM helped us with the technical aspects of our project
3. Our TM treated the team respectfully and professionally
4. Our TM responded to emails in a timely manner
5. Our TM was available to meet regularly with the team
6. Our TM meetings were productive
7. Our TM provided useful feedback on written deliverables
8. Our TM met with the team to review/practice major presentations[4]
9. Our TM offered suggestions and ideas without dictating what the team should do
10. Our team felt free to express any concerns we had (technical or otherwise) to our Team Mentor

Each question was answered using a four-point scale of Always (4), Very Often (3), Sometimes (2), Seldom/Never (1). A response to each question is required. In addition, there is an optional question in which students can provide anonymous written feedback to their TM if they wish. This evaluation is completed individually by each member of a team.

Data has been collected for each cohort beginning in Spring 2019. The only exclusions were the second semester teams in Spring 2020 (shutdown by COVID and teams were unable to complete their projects) and the following Summer 2020-Fall 2020 cohort when we did not have externally sponsored projects, again due to COVID, and did not assign TMs to the teams in that cohort.

The results reported here cover a total of 285 project teams across 11 cohorts that completed 2637 individual evaluations of their TM. This evaluation is not a graded assignment, but it is a required course deliverable. Overall, the response rate was 98.3%.

Breaking down the evaluations by TM source reveals that 28 projects were mentored by the instructors, 30 by tenured/tenure-track faculty, 58 by non-tenure track teaching faculty, 27 by graduate student/post-doctoral researchers, and 142 by external engineers.

Results and Discussion

Figure 2 shows the average TM rating across all 10 questions for each of the five groups. In this figure and those which follow, the groups are abbreviated as instructors (INST), non-tenure track teaching faculty (NTT), external engineers (EXT), graduate student/post-doctoral researchers (GS/PD), and tenured/tenure-track faculty (TT).

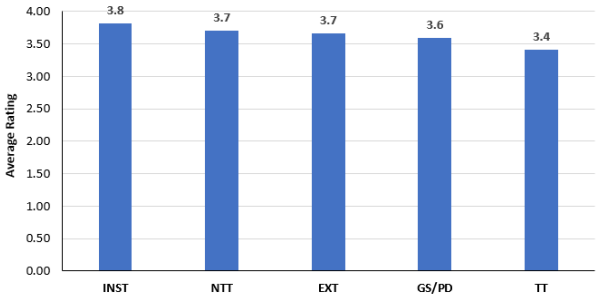

Figure 2: Average ratings for the groups.

The results of these evaluations show that all TMs are performing their functions well. This conclusion is supported by the generally positive written comments made by students to their TM and the fact that out of the 2637 evaluations, only 160 (5.57%) had an overall average below 3.0, and of these a mere 17 (0.59%) had an average below 2.0.

While there are slight differences in evaluation scores between the different TM groups, we do not attach too much significance to these differences. The lowest group averages a 3.4, nearly halfway between "Very Often" (3) and "Always" (4). It was encouraging to see that the external engineers had a comparably high average rating given that many of them have less experience working with students. It is also not surprising that the instructors have the highest average since they have the most experience with the course and its requirements.

Figure 3 presents a more detailed view of the results. This figure shows the average ratings for each group for each question. Again, the results show that the TMs from all groups are performing well in each aspect of the evaluation with ratings falling between "Very Often" (3) and "Always" (4). It is evident that there are some aspects of the evaluation for which there is a wider spread of the ratings than for others. Since our goal was to improve the overall mentoring experience for our students, questions with a larger spread in average ratings may indicate areas where we need to improve our training and preparation of TMs or ensure that students have a clear understanding of the TM's role.

To get a better view of this spread, the standard deviation of the average response by TM group for each question is plotted in Figure 4. The smallest standard deviation was associated with the "relationship" questions ("Our team felt free to express any concerns we had (technical or otherwise) to our Team Mentor" and "Our TM treated the team respectfully and professionally"). All groups had a rating greater than 3.5, indicating that there were positive, productive relationships between students and mentors from all groups. It was also encouraging to see that all TMs respected the boundaries of their advisory role ("Our TM offered suggestions and ideas without dictating what the team should do").

On the other hand, the largest standard deviations were for questions related to the TM providing technical assistance and monitoring progress. Although we strive to find TMs that are familiar with the project topic, we need to make sure that students understand their TM's role (i.e., they are not a subject matter expert). We instruct both teams and TMs to include a review of the schedule in each meeting. These results suggest that our training for TMs needs to reinforce the importance of this.

The remaining questions show that there are some differences among TM groups related to meetings, scheduling, and email communications. These items are a challenge considering that the TMs (many from off campus) have busy work schedules, travel, other commitments, etc. We consider these results to be good given these realities. Of course, these are good points to reinforce with both the students and TMs.

As the results are very close, we thought it would be more interesting to look at responses to individual questions, particularly questions that have a larger number of low responses (1s and 2s). Out of the ten questions, only one had an average below 3 for a specific TM group. Question #2 ("Our TM helped us the with technical aspects of our project") had an average score of 2.966 for tenure-track TMs. As mentioned above the TM's role is not to be a technical resource for the team, but to coach and guide them through the project process.

Probing further into the responses to look at the number of 1s and 2s that were given to the TMs on the individual questions reveals that overall only 0.91% of the responses were 1s and 6.06% were 2s.

Question #2 stands out for having larger numbers of low responses, with 2.20% responding with a 1 and 14.90% responding with a 2 for their TM. Our belief is this is due to the team looking to the TM to be a technical resource when that is not their role.

Question #3 (Our TM treated the team respectfully and professionally") stands out for the extremely low number of 1s and 2s given to the TMs, with only 2 out of 2637 (0.08%) responses being a 1 and only 55 (2.09%) responses of a 2 given. We believe that this goes back to the initial training that the TMs go through to help them understand their role and what the expectations are for their interactions with their team.

Figure 3: Average ratings for each question.

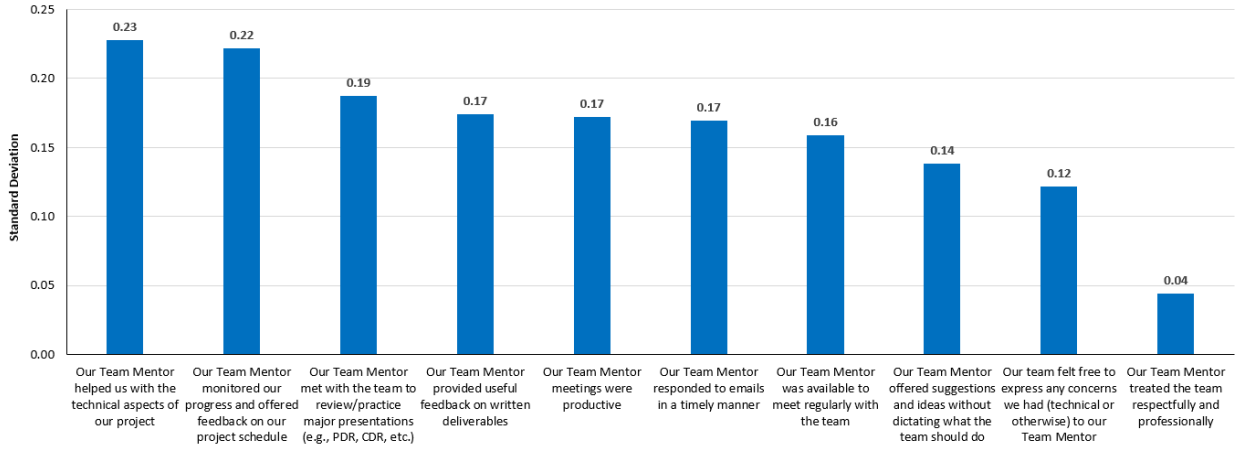

Figure 4: Standard deviation for each question.

Conclusion

In a large capstone course the opportunity for effective instructor-team interaction is limited and if not addressed or compensated for, can lead to poor team performance. At UTD we address this by assigning a Team Mentor (TM) to each team that meets with them weekly to review progress and to coach and guide the team. There are five sources for these TMs.

The team evaluates their TM at the end of each semester of the two-semester project. The results of these evaluations are provided to the TMs to help them improve their performance. We have tracked these evaluations over the course of 11 cohorts with 2637 total individual evaluations. Overall these evaluations are highly positive (an overall average of 3.65), with little variation between the highest rated source of TMs (3.82) and the lowest (3.41).

We train the TMs at the beginning of each capstone cohort to help prepare them for this role. Overall the TM training program appears to be working, as average ratings have varied little and remained high, despite each cohort of TMs including new people that have no previous TM experience. The results do point to areas where we can further improve our training. In future work it would be beneficial to correlate TM ratings with project evaluations. We believe this correlation will provide additional insight into TM effectiveness.

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