Assessing Communications and Teamwork Using Peer and Project Sponsor Feedback in a Capstone Course

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Abstract

Capstone design courses are used to bring together various aspects of a student's curriculum into a culminating project; they also provide an opportunity to practice and assess professional skills using an authentic design project. While peer feedback and sponsor feedback are often used to assess learning outcomes and even provide input into student grades, these metrics can also serve to assess course interventions and can be correlated with each other. This work examines the use of student feedback regarding their teammates, project sponsor feedback, and uses these for the assessment of an online project management tool. This is done in a two-semester capstone course in a four-year engineering technology program.

One of the recurring issues in the capstone course examined in this work was the lack of communication with project sponsors; the sponsors complained that they did not have access to project information or insight into project progress. To alleviate this issue, an online project management tool was implemented in the fall of 2015. This tool allowed students to easily share project documents and information with sponsors. Project sponsor feedback from semesters of capstone projects were collected prior to the implementation of the online tool; these are compared to feedback from the semesters since the tool has been implemented. Also used to assess the project teams was a peer review rubric which asked how often teammates engages in particular traits: helping, listening, participating, persuading, questioning, respecting, and sharing.

Project sponsors, while generally satisfied with their projects, are shown not to be satisfied with the frequency of the updates they receive from their project teams. Results show the update frequency variable is significantly correlated with almost all other project satisfaction variables; more frequent updates leading to higher satisfaction. The project team peer review variables are generally positively correlated with overall project satisfaction. In the cases of participating and persuading, these correlations are significant. The standard deviation of the project team peer reviews are negatively correlated with overall project sponsor satisfaction. The implementation of the online project management tool is not shown to have a significant effect on project sponsor satisfaction and in some cases leads to poorer average ratings. However, the feedback related to project documentation is shown to improve slightly after the implementation of the online tool. Insights into the implementation of the various aspects of the work and future research questions are detailed.

Introduction

Capstone design courses and projects represent the culmination of an engineering or engineering technology undergraduate curriculum; they are a key aspect of a technical education experience. The goal of these courses is to move students away from theory and more towards the practical problem solving that they will encounter in industry [1-3]. Capstone projects are often multidisciplinary [4], further replicating the types of projects students will experience in industry. Capstone projects can be defined as project-based learning. Project-based learning brings skills and knowledge together to solve an ill-defined or poorly formed project [5]. This is epitome of the capstone experience. Students generally have their capstone experience in either the last of last two semesters of their degree program. They likely have completed the majority of their

technical curriculum and will use that knowledge to solve a problem presented by the faculty or an industry sponsor.

Capstone projects benefit from the general positive attributes associated with project-based learning. These benefits include improved self-efficacy[6]; self-efficacy is the belief one has in one's ability to complete certain tasks. Studies suggest that the type of project-based learning associated with capstone courses can improve student motivation [7, 8]. Capstone projects are also noted for promoting the skills to create "lifelong learners" [9].

Some of the key learning outcomes for capstone projects are professional skills [10]. ABET accreditation criteria and industry demands have increased the focus on these professional skills [11]. In the context of ABET, Shuman *et al.* [11] broadly characterize these professional skills to include: teamwork, ethics, communication, societal impact understanding, life-long learning, understanding current issues. Several of these professional skills were identified as important or key differentiators for potential employees [12]. For the purpose of this work, the key professional skills include communications, teamwork, and project management.

This work examines how a capstone course that was recently (starting in fall 2014) expanded to a two-semester capstone experience (as opposed to a single semester) was viewed by project sponsors in terms of communications and overall project deliverables. The relationship between this assessment and student peer assessments are also evaluated. A comparison is made between the pre- and post-implementation of a project management website tool. The paper is organized as follows. First background about the degree program and courses is detailed. Next, the instruments for data collection and the alternative aspects investigated are detailed. The results of the analysis are then presented. Finally, conclusions are limitations are discussed.

Background and Methods
This work examined the sponsor and peer feedback of a capstone design course. This course serves as the culmination of a Manufacturing and Mechanical Engineering Technology program in the Department of Engineering Technology and Industrial Distribution at Texas A&M University. The capstone course was transitioned from a one-semester project course to a two-semester project course beginning in the fall of 2014. Previously students took a project management course during which they learned about project and people management techniques; as part of that course, students wrote a proposal for a fictitious project of their choosing. During the follow-on capstone design course, students worked on a project that was either sponsored by industry or was proposed by a faculty member as part of their educational or research needs. Beginning in fall of 2014, students were assigned a project after about one month of project management instruction. This project was then carried on for a second semester in what was the traditional capstone course. During the first semester of the capstone experience, students were tasked with working with the sponsor to write a formal proposal. After the proposal was accepted, the students advanced their design; the goal at the end of the first semester was a detailed design and design review with the class and the project sponsor. In the second semester the projects were to be advanced to ideally complete a build and test sequence. The second semester capstone project course included both a mid-term design review and report and then a final design review and report.

Initially, in both the project management course and the capstone design course, students were tasked with keeping project ideas and meeting notes in a log book. This log book was a composition book that is similar to the lab notebooks often used in industry. The log books were

periodically checked for completeness and represented approximately 5% of the overall grades in both courses. After the proposal was accepted, students were also assigned a weekly progress memo. These memos were turned in to the instructor and during class a brief oral report of project progress was also delivered. This was carried over from the traditional capstone course. In both courses, students were asked to keep their sponsors informed of project progress through weekly contact. The memo was offered as an option to provide this weekly update. At the end of the projects, students were asked to deliver all project documentation (e.g., reports and designs) and artifacts to the project sponsor. A copy of all project documentation was also to be turned in to the course instructor for archival purposes.

Beginning in the fall of 2015, the project management website Basecamp (https://basecamp.com/) was implemented into the course. Basecamp is an online collaborative tool that allows the posting of documents, tasks, shared calendars, and other project management tools. The instructor set up the Basecamp sites for each of the projects. Project sponsors were also invited to join the Basecamp site. Basecamp allows for customers to be designated and given limited access to project files based on project team assigned permissions. Just as with the traditional log books, students were told that their Basecamp sights would be checked periodically and that their updating and content on the site represented 5% of their grade in each of the courses. Basecamp allows for postings to be viewed by each individual associated with the project.

As part of the overall redesign of the capstone experience, a project sponsor survey was implemented beginning with those projects that ended in the spring of 2015 (those beginning in fall 2014). The project sponsor survey was distributed at the end of the project. Sponsors were told that their feedback would not have bearing on the students' grades, but that it was part of the program's assessment and continuous improvement plan (which it is). The questions in the project sponsor survey are shown in Appendix A. Questions 1 and 10 are free response questions which capture the project title and any sponsor comments, respectively. With the exception of question 5, they are all coded on a 7-point Likert[13] scale where 7 is the maximum and 1 is the minimum. Question 5 deals with communication frequency; in this case, the numerical coding is reversed with more frequent communication receiving a smaller number (1 – weekly; 2 – biweekly; 4 – monthly; 6 – less than monthly). The goal here was to assign numerical values that represented relative frequency.

Up until the projects beginning in the spring of 2015 (ending in the fall of 2015), students had been asked to rate their teammates on an overall contribution out of 10 points and provide an explanation. Beginning with projects starting in the spring of 2015, a new peer rating system was implemented. This rating system asked students to rate each of their teammates on seven traits: Helping, Listening, Participating, Persuading, Questioning, Respecting, and Sharing. These ratings were based on a 4-point scale with 4 being the maximum and most positive rating. This teammate rubric is shown in Appendix B. Peer feedback in this work is reported at the team level; the overall average for each project and the standard deviation for the team members working on that project are the reported variables. This teaming rubric was introduced by Benzley *et al.* [14]. To assess the impact of Basecamp on sponsor feedback and the role of peer assessment on sponsor ratings, the various data from these surveys were combined and statistically analyzed. The results are shown in the next section.

Results

As described above, the various data sets were combined to assess the impact of Basecamp implementation and peer review on sponsors' perceptions of their projects. Given that various aspects were introduced at different times, the data set is not complete for all aspects over time. Feedback for a total of 25 projects was collected from the total of 37 projects that were completed over this timeframe. The summary of the numerical data from these projects are shown in Table 1. For the first three sponsor feedback questions, responses were relatively positive; sponsors generally believed they received feedback on the initial plan, had input and agreed that they received regular updates. The average frequency of updates was less than bi-weekly (an average numerical rating of 2.60). The agreement with the satisfactory nature of the updates was only slightly positive. The documentation and overall satisfaction of the results were all relatively positive, having values greater than 5. The team peer review feedback was also generally positive. On a scale of 4, all results were at least 3.5 signifying a general agreement that team members behaved positively.

Table 1. Descriptive Statistics for Feedback and Team Assessment Variables

	N	**Mean**	*SD*
Tentative Plan Communication	25	5.64	1.58
Input on Plan	25	6.08	0.86
Regular Updates	25	5.04	1.77
Update Frequency	25	2.60	1.66
Update Frequency Satisfaction	25	4.76	1.74
Preliminary Documentation	25	5.72	1.28
Final Documentation	25	5.28	1.67
Overall Satisfaction	25	5.36	1.68
Helping	18	3.60	0.28
Listening	18	3.62	0.31
Participating	18	3.51	0.27
Persuading	18	3.50	0.32
Questioning	18	3.61	0.37
Respecting	18	3.69	0.38
Sharing	18	3.64	0.31

To examine the relationship between sponsors' perceptions of their projects and peer feedback ratings correlations of these variables are analyzed; this represented 18 of the total projects. In Table 2, the relationships between project sponsor ratings and peer feedback averages are shown; significance is shown parenthetically below each correlation. As expected, most of the sponsor feedback ratings are positively correlated. The exception is the update frequency (which was negatively coded with lower numbers signifying more frequent updates), this variable is negatively significantly correlated with almost all of the other sponsor review metrics. The only exception is the communication of the tentative project plan; the tentative project plan was part of the proposal and had a set deadline. This would indicate that sponsors really desire frequent communication with their project teams. Likewise, the correlations for the various team peer reviews are also highly and significantly correlated. This may be due to students giving team members that performed well better ratings in other categories. In the case of overall project satisfaction, all of the peer review ratings are positively correlated. The listening and participating categories are significantly correlated.

Table 2. Correlations of Sponsor Feedback and Average of Teammate Peer Review for All Data

	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1. Tentative Plan Communication	0.451* (0.024)	0.528** (0.007)	-0.376 (0.064)	0.605** (0.001)	0.258 (0.212)	0.372 (0.067)	0.522** (0.007)	0.262 (0.293)	0.364 (0.138)	0.488* (0.04)	0.239 (0.339)	0.256 (0.306)	0.305 (0.218)	0.141 (0.577)
2. Input on Plan	■	0.627** (0.001)	-0.618** (0.001)	0.625** (0.001)	0.400* (0.047)	0.446* (0.025)	0.583** (0.002)	0.312 (0.207)	0.412 (0.089)	0.433 (0.073)	0.379 (0.121)	0.339 (0.169)	0.314 (0.205)	0.150 (0.554)
3. Regular Updates		■	-0.776** (0.000)	0.939** (0.000)	0.597** (0.002)	0.673** (0.000)	0.837** (0.000)	0.199 (0.428)	0.448 (0.063)	0.341 (0.165)	0.340 (0.167)	0.271 (0.276)	0.294 (0.237)	0.117 (0.645)
4. Update Frequency			■	-0.699** (0.000)	-0.587** (0.002)	-0.634** (0.001)	-0.709** (0.000)	-0.014 (0.957)	-0.177 (0.483)	-0.264 (0.291)	-0.102 (0.686)	-0.092 (0.717)	-0.083 (0.745)	0.050 (0.843)
5. Update Frequency Satisfaction				■	0.513** (0.009)	0.684** (0.000)	0.815** (0.000)	0.265 (0.288)	0.489* (0.04)	0.361 (0.141)	0.342 (0.165)	0.278 (0.265)	0.382 (0.118)	0.185 (0.463)
6. Preliminary Documentation					■	0.625** (0.001)	0.652** (0.000)	0.064 (0.8)	0.197 (0.433)	0.079 (0.755)	0.191 (0.447)	0.054 (0.832)	0.097 (0.702)	-0.077 (0.762)
7. Final Documentation						■	0.897** (0.000)	0.265 (0.288)	0.377 (0.123)	0.241 (0.336)	0.206 (0.413)	0.221 (0.377)	0.351 (0.153)	0.167 (0.507)
8. Overall Satisfaction Mean							■	0.399 (0.101)	0.538* (0.021)	0.517* (0.028)	0.408 (0.092)	0.415 (0.087)	0.451 (0.06)	0.273 (0.273)
9. Helping Mean								■	0.899** (0.000)	0.809** (0.000)	0.857** (0.000)	0.886** (0.000)	0.911** (0.000)	0.890** (0.000)
10. Listening Mean									■	0.847** (0.000)	0.914** (0.000)	0.926** (0.000)	0.950** (0.000)	0.894** (0.000)
11. Participating Mean										■	.857** (0.000)	0.904** (0.000)	0.827** (0.000)	0.792** (0.000)
12. Persuading Mean											■	0.935** (0.000)	0.916** (0.000)	0.869** (0.000)
13. Questioning Mean												■	0.939** (0.000)	0.898** (0.000)
14. Respecting Mean													■	0.923** (0.000)
15. Sharing Mean														■

Note: *Correlation is significant at the 0.05 level (2-tailed); ** Correlation is significant at the 0.01 level (2-tailed).

Table 3. Correlations of Sponsor Feedback and Standard Deviation of Teammate Peer Review for All Data

	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1. Tentative Plan Communication	0.451* (0.024)	0.528** (0.007)	-0.376 (0.064)	0.605** (0.001)	0.258 (0.212)	0.372 (0.067)	0.522** (0.007)	-0.464 (0.052)	-0.407 (0.094)	-0.422 (0.081)	-0.357 (0.146)	-0.271 (0.277)	-0.455 (0.058)	-0.375 (0.125)
2. Input on Plan		0.627** (0.001)	-0.618** (0.001)	0.625** (0.001)	0.400* (0.047)	0.446* (0.025)	0.583** (0.002)	-0.457 (0.057)	-0.282 (0.256)	-0.431 (0.074)	-0.205 (0.416)	-0.168 (0.506)	-0.332 (0.178)	-0.174 (0.49)
3. Regular Updates			-0.776** (0.000)	0.939** (0.000)	0.597** (0.002)	0.673** (0.000)	0.837** (0.000)	-0.262 (0.294)	-0.323 (0.192)	-0.195 (0.438)	-0.312 (0.208)	-0.183 (0.468)	-0.441 (0.067)	-0.171 (0.498)
4. Update Frequency				-.699** (0.000)	-0.587** (0.002)	-0.634** (0.001)	-0.709** (0.000)	0.349 (0.156)	0.115 (0.65)	0.538* (0.021)	0.310 (0.21)	0.167 (0.507)	0.168 (0.506)	0.285 (0.252)
5. Update Frequency Satisfaction					0.513** (0.009)	0.684** (0.000)	0.815** (0.000)	-0.303 (0.222)	-0.387 (0.112)	-0.134 (0.596)	-0.274 (0.272)	-0.191 (0.447)	-0.504* (0.033)	-0.193 (0.442)
6. Preliminary Documentation						0.625** (0.001)	0.652** (0.000)	-0.229 (0.361)	-0.078 (0.758)	-0.229 (0.36)	-0.256 (0.306)	-0.055 (0.829)	-0.227 (0.365)	-0.071 (0.781)
7. Final Documentation							0.897** (0.000)	-0.368 (0.133)	-0.350 (0.155)	-0.157 (0.535)	-0.257 (0.304)	-0.317 (0.199)	-0.419 (0.083)	-0.298 (0.23)
8. Overall Satisfaction SD								-0.446 (0.063)	-0.443 (0.065)	-0.294 (0.237)	-0.325 (0.188)	-0.325 (0.189)	-0.546* (0.019)	-0.326 (0.187)
9. Helping SD									0.764** (0.000)	0.753** (0.000)	0.725** (0.001)	0.764** (0.000)	0.729** (0.001)	0.780** (0.000)
10. Listening SD										0.428 (0.076)	0.801** (0.000)	0.873** (0.000)	0.944** (0.000)	0.830** (0.000)
11. Participating SD											0.687** (0.002)	0.506* (0.032)	0.305 (0.218)	0.703** (0.001)
12. Persuading SD												0.860** (0.000)	0.735** (0.001)	0.843** (0.000)
13. Questioning SD													0.861** (0.000)	0.816** (0.000)
14. Respecting SD														0.690** (0.002)
15. Sharing SD														

Note: *Correlation is significant at the 0.05 level (2-tailed); ** Correlation is significant at the 0.01 level (2-tailed).

In addition to understanding the effect of average team peer review ratings on project outcome assessments, the standard deviation of peer review ratings were also analyzed. Higher standard deviations of peer reviews would signify teams that had poorly performing members or possible other teaming issues. Similar to peer review ratings, the standard deviations of the various peer review categories are also significantly positively related. In the case of the overall project satisfaction from the sponsor, all of the peer review standard deviations are negatively correlated. However, only the Respecting standard deviation is statistically significant. This would indicate that teams that had more variability in their peer reviews (i.e., some low performing members) performed more poorly on their projects as perceived by the sponsor. The Respecting standard deviation is also significantly negatively correlated with project update frequency satisfaction.

To examine the role of the Basecamp implementation on project sponsor satisfaction, independent *t*-tests were used to assess pre- and post-Basecamp implementation responses. These results are shown in Table 4. The first four project sponsor feedback variables were actually worse after the implementation of the Basecamp tool. In the case of input into the project plan, this difference approached statistical significance. The only variables that were preferable under Basecamp were those related to preliminary and final documentation. The students may have been relying on Baseccamp too much and chosen not to communicate with their project sponsors. The documentation might have been available online for the sponsors, thus leading to higher ratings in those cases.

Table 4. Comparison of Sponsor Feedback with and without Basecamp Implementation

	With Basecamp			Without Basecamp				
	N	**Mean**	*SD*	*N*	**Mean**	*SD*	*t*	*p*
Tentative Plan Communication[†]	14	5.21	1.93	11	6.18	0.75	-1.719	0.103
Input on Plan	14	5.79	0.89	11	6.46	0.69	-2.050	0.052
Regular Updates	14	4.93	1.94	11	5.18	1.60	-0.349	0.730
Update Frequency	14	2.57	1.74	11	2.64	1.63	-0.095	0.925
Update Frequency Satisfaction	14	4.57	1.87	11	5.00	1.61	-0.604	0.552
Preliminary Documentation	14	5.86	1.23	11	5.55	1.37	0.598	0.555
Final Documentation	14	5.43	1.40	11	5.09	2.02	0.493	0.626
Overall Satisfaction	14	5.29	1.59	11	5.46	1.86	-0.244	0.809

[†]Note: Equal variances not assumed.

Conclusions
Capstone projects seek to improve professional skills in students. Two of the key professional skills associated with capstone projects, are the ability to communicate effectively and the ability to work in a team. To examine the role of student peer feedback on project sponsor perceptions of success in a two semester capstone project, various sets of feedback data were correlated. These data were also used to examine the implications of implementing an online project management tool in the course. Project sponsors were generally satisfied with their projects; this was indicated by the overall high average ratings they assigned their project teams. The sponsors were not satisfied with the frequency of the updates they received from their project teams. The update frequency variable was significantly correlated with almost all other project satisfaction variables; more frequent updates led to higher satisfaction. The project team peer review variables were generally positively correlated with overall project satisfaction. In the cases of participating and persuading, these correlations were significant. The standard deviation of the project team peer reviews were negatively correlated with overall project sponsor satisfaction.

The implementation of the online project management tool did not have a significant effect on project sponsor satisfaction and in some cases led to poorer average ratings. Project sponsors may not have been using the online tool as much as students thought they would. This may have led the students to have less direct contact with the project sponsors. The overall satisfaction with the projects was slightly higher prior to the implementation of the online tool. These results indicate that the implementation of a new tool is not likely a "cure all" for project communication needs. More work and intervention is likely needed.

The results presented need to be viewed within the limitations associated with the work. First the pre- and post-Basecamp implementation number of projects is relatively small. This is especially true given the variety of projects that are typically assigned for capstone. Second, the confounding variable of class size is not included. Enrollment in the courses increased over the past few years; this led to larger project teams and may have led to more "social loafing" in some of the projects. Overall, the results indicate the high performing teams (with higher ratings and lower standard deviations) deliver projects that are more satisfactory to project sponsors. The results also indicate that sponsors desire more constant feedback.

To implement these results into the course, the course instructor will implement more frequent peer review feedback to get poor performing team members back on track sooner. The instructor will also better monitor team communications with the sponsors to improve that aspect. Finally, the instructor will remind sponsors of their Basecamp account and add a survey question to assess the frequency of their access to their team's site.

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Appendix A. Project Sponsor Survey

Q1. Please provide the title or a brief description of the project you or your company sponsored.

[   ]

Q2. The project team communicated the tentative overall project plan to me near the beginning of the project.

Strongly Disagree	Disagree	Somewhat Disagree	Neither Agree or Disagree	Somewhat Agree	Agree	Strongly Agree
☐	☐	☐	☐	☐	☐	☐

Q3. I felt that I had significant input with respect to the direction the project was going.

Strongly Disagree	Disagree	Somewhat Disagree	Neither Agree or Disagree	Somewhat Agree	Agree	Strongly Agree
☐	☐	☐	☐	☐	☐	☐

Q4. I received regular updates of the project's status from the project team.

Strongly Disagree	Disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Agree	Strongly agree
☐	☐	☐	☐	☐	☐	☐

Q5. How frequent were the status updates?

- ☐ More than weekly
- ☐ Approximately weekly
- ☐ Bi-weekly
- ☐ Monthly
- ☐ Less than monthly

Q6. I was satisfied with the frequency of project status updates I received.

Strongly agree	Agree	Somewhat agree	Neither agree nor disagree	Somewhat disagree	Disagree	Strongly disagree
☐	☐	☐	☐	☐	☐	☐

Q7. I received preliminary documentation of the concepts the project team was considering.

Strongly agree	Agree	Somewhat agree	Neither agree nor disagree	Somewhat disagree	Disagree	Strongly disagree
☐	☐	☐	☐	☐	☐	☐

Q8. I received final project documentation that was consistent with the requirements of the project.

Strongly agree	Agree	Somewhat agree	Neither agree nor disagree	Somewhat disagree	Disagree	Strongly disagree
☐	☐	☐	☐	☐	☐	☐

Q9. Taking into account my overall view of the project and deliverables, I would say that I am:

Extremely unsatisfied	Unsatisfied	Somewhat unsatisfied	Neither satisfied nor unsatisfied	Somewhat satisfied	Satisfied	Extremely Satisfied
☐	☐	☐	☐	☐	☐	☐

Q10. Please use this space to provide any additional comments, questions, or suggestions. Also, please let me know if you would like to discuss this project further.

[   ]

Appendix B. Teammate Participation Rubric

Reflecting on your teammates' participation within the group project, rate each teammate using the following rubric. Add your teammates' names on the next page and corresponding points you award them. The teamwork points will be averaged and figured into your teammates' final grade.

Trait	Criteria			
	1	2	3	4
Helping	The teammate never offered assistance to other teammates.	The teammate sometimes offered assistance to others.	The teammate offered assistance to each other most of the time.	The teammate always offered assistance to other members.
Listening	The teammate never worked from others' ideas.	The teammate sometimes worked from others' ideas.	The teammate worked from others' ideas most of the time.	The teammate always worked from others' ideas.
Participating	The teammate never contributed to the project.	The teammate sometimes contributed to the project.	The teammate contributed to the project most of the time.	The teammate always contributed to the project.
Persuading	The teammate never exchanged, defended, and rethought ideas.	The teammate sometimes exchanged, defended, and rethought ideas.	The teammate exchanged, defended, and rethought ideas most of the time.	The teammate always exchanged, defended, and rethought ideas.
Questioning	The teammate never interacted, discussed, or posed questions to other team members.	The teammate sometimes interacted, discussed, and posed questions to other team members.	The teammate interacted, discussed, or posed questions to other team members most of the time.	The teammate always interacted, discussed, or posed questions to other team members.
Respecting	The teammate never encouraged and supported the ideas and efforts of others.	The teammate sometimes encouraged and supported the ideas and efforts of others.	The teammate encouraged and supported the ideas and efforts of others some of the time.	The teammate always encouraged and supported the ideas and efforts of others.
Sharing	The teammate never offered ideas or reported his/her findings to others.	The teammate sometimes offered ideas and reported his/her findings to others.	The teammate sometimes offered ideas and reported his/her findings to others.	The teammate always offered ideas and reported his/her findings to others.