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KEEPING AN EYE ON THE TEAM: DEVELOPING AN OBSERVATIONAL TOOL FOR STUDENT TEAMS

Abstract:

Teamwork is an essential component of the engineering design process. Engineers in today's globalized economy must be able to work in multidisciplinary teams. As such, graduates of engineering programs must be able to apply their technical knowledge in team-based environments where flexibility, communication, and cooperation are needed to solve problems that do not necessarily have well-defined technical boundaries. The current study is part of an ongoing project addressing teamwork skills at the Petroleum Institute (PI), an engineering university in the United Arab Emirates (UAE).

Although a variety of soft skills, such as teamwork, communication, and project management are incorporated into the current curriculum at the PI, teamwork can be a particularly challenging soft skill to acquire and to teach. The quality of team experiences is dependent on team members' perceptions of their group dynamics and the contributions that individuals make to the team. As students at the PI are segregated by gender (a common practice in government universities within the Gulf Arab region), the socio-cultural context provides a unique environment for the study of team dynamics. A number of tools are being used to investigate teamwork at the PI, including peer evaluations, student interviews, surveys, and teacher observations. However, in order to ascertain whether student teams are actually functioning in an effective manner (as compared to students' perceptions of this phenomenon), it is important to specify the teamwork behaviors that are expected of effective teams. This is particularly relevant for student teams as the one of the goals should be to provide specific and measurable feedback to help students improve their performance.

The present study provides insight into the development of an observational tool for identifying team behaviors among students at the PI. Although the project revolves around engineering students, the observation tool can be used to evaluate teamwork behaviors in any discipline. The tool adapts the

competencies and behaviors of a computer-based peer feedback system known as Team Developer. The presentation will discuss the process involved in the development of the observational tool, its alignment to industry benchmarks, as well as the development of protocols and options for administering the behavioral instrument. The advantages and challenges of incorporating a behavioral assessment for teamwork will also be discussed.

Keywords:

teamwork behaviors, behavioral instrument development, student teams

JEL Classification: I23, I20, I29

Introduction

Engineers in today's globalized economy must be able to work in multidisciplinary teams in order to be successful. Graduates of engineering programs must be able to apply their technical knowledge in team-based environments where flexibility, communication, and cooperation are needed to solve problems that do not necessarily have well-defined technical boundaries. In order to train engineers for this challenge, universities are increasingly including project-based learning as a tool for improving student competency in teamwork. Despite this focus, evaluating students' ability to work in teams continues to be a difficult endeavor.

Student outcomes and competencies are heavily factored into the Accreditation Board of Engineering and Technology (ABET) criteria for engineering programs. Thus, university programs are pressured by both industry and accreditation bodies to focus on incorporating sound assessments of key knowledge into engineering coursework. Teamwork can be particularly challenging in this respect. A team can be defined as a group of individuals that (1) share a collective identity, (2) share goals to reach a common outcome, (3) work interdependently through assigned tasks, (4) have distinct roles within the group, and (5) interact within a larger organizational context that influences their work (Morgeson, Lindoerfer, Loring, 2009; Kozlowski, Ilgen, 2006). As a concept, thus, teamwork consists of a number of factors that are often intertwined and difficult to capture in a systematic manner.

Ways of Assessing Teamwork

A number of strategies can be employed to determine how students are performing on team-based projects. These include both product assessments as well as process assessments (Marin-Garcia, Lloret, 2008). Product assessments may be in the form of team reports and presentations, which are relatively traditional sources of evaluation. However, product assessments cannot really help with the development of teamwork skills among individual team members. For example, a final report that receives high marks for all team members may have essentially been completed by one or two high-achieving students. Thus the team product may have been excellent, but in this case, the teamwork itself would be considered poor (Hughes, Jones, 2011).

Testing knowledge of individual teamwork skills can be done through traditional means, such as multiple choice tests where test-takers respond to scenarios related to common teamwork components, including communication, conflict resolution, collaborative problem solving, and project management. These types of tests are often used to staff work teams in organizations (Hughes, Jones, 2011). However, this may not be the best approach for student teams, where knowing about conflict resolution may be less effective

for learning than actually having the opportunity to apply conflict resolution strategies in teamwork.

Evaluating the process of teamwork in university courses, therefore, often relies on less traditional methods, including peer evaluations, student interviews, surveys, and teacher observations (Lingard, 2010). These methods are more reflective of actual tasks that students perform, thus serving a more educational role in assessing teamwork. Rather than assessing theoretical knowledge, "educative assessments" (Wiggins, 1998) rely on authentic tasks where feedback allows students to reflect on their performance by understanding their areas of strength as well as those areas that need improvement. These types of assessments can also help faculty as they guide students through the learning process.

Peer evaluations are a commonly used educative assessment in higher education courses. These are often a combination of open-ended and Likert-type questions where students are asked to assess each other on their team process. One systematic peer evaluation system that has been successfully implemented is the Team Developer tool that uses specific behavioral components of teamwork and asks students to rate themselves and each other on those. By focusing on observable behaviors, rather than subjective impressions, the tool allows users to determine team members' participation in a more objective manner (McGourty, Dominick, Reilly, 1998).

Background of the Study

The current study was conducted to gain information on the best ways to assess teamwork behaviors at The Petroleum Institute (PI), an engineering university in the United Arab Emirates. The university, like many government institutions in the Gulf Arab region, is gender-segregated with one campus for male students and a separate campus for female students. This, however, does not apply to instructional staff and so, students may be taught by either male or female professors. The course offerings and graduation expectations are the same on both campuses.

The PI currently offers undergraduate and graduate majors in Electrical, Mechanical, Chemical, and Petroleum Engineering, as well as Petroleum Geoscience. One of the major financial sponsors of the PI is the Abu Dhabi National Oil Company (ADNOC), which provides scholarships and stipends to UAE nationals, as well as guaranteed job placement at the end of students' degree programs. The majority of students are English language learners, with Arabic as their home language. Students must earn a minimum score of 500 on the TOEFL or a 6 on the IELTS exam to gain entry to the freshman year courses. Students who do not meet the entrance criteria are provided extra support and

instruction in the English language through the university Academic Bridge Program (ABP).

Once they matriculate, students at the PI take a set of courses in the freshman and sophomore years that provide the foundation for upper level study in their chosen major. Students take introductory courses in Physics, Chemistry, and Mathematics, as well as courses in Communications, and Engineering Design. These courses are a part of the Arts and Sciences (A & S) Department and help students become familiar with the oil and gas industry, gain experience in oral, written, and graphical communication, and become familiar with the engineering design process. The communications and introductory design courses are particularly focused on using project-based learning to improve the professional "soft" skills that students need be successful engineers (Pasha-Zaidi, 2014). As teamwork is a crucial aspect of these courses, the current team of researchers set out to determine a systematic and observable way to assess teamwork skills that could be easily utilized by instructors in any of the relevant A & S courses.

Although a number of tools are being used to investigate teamwork at the PI, including peer evaluations, student interviews, observations, and surveys, in order to ascertain whether student teams are actually functioning in an effective manner (as compared to students' perceptions of their behaviors), it is important to specify the teamwork behaviors that are expected of effective teams. This is particularly relevant for student teams as the one of the goals of industry and ABET is to provide specific and measurable feedback to help students improve their performance.

Measuring Teamwork at the PI

Although teamwork can be measured from either the quality of the team product or the quality of the team process, ideally a combination of the two would provide a better picture of teamwork than either aspect alone. Two studies conducted at the PI offer some insight for the ways in which teamwork is perceived by students. A pilot study conducted with female students in the introductory engineering design course (Pasha-Zaidi, Mohamed, 2014) showed that students' satisfaction with their teams increases over time and that students may perceive their teams to be effective, even if they are not satisfied with their team members. A comparative study of male and female students at the PI was also conducted to explore any possible gender differences with regard to perceptions of team satisfaction and effectiveness. The study found significant differences in perceptions of team satisfaction and effectiveness between male and female students. Male students rated their team satisfaction higher than female students, and female students reported higher team effectiveness than male students. The female students in this study emphasized the quality of their team processes and the effort of the team members, whereas the male students emphasized the end product of their teamwork. The studies

provided some insight into the behavioral manifestations that students considered effective (such as attendance in team meetings and getting work completed in a timely manner); however, they did not delve into team member behaviors from an observable or quantifiable standpoint.

Peer evaluations are used in the communications and engineering design courses to allow students a chance to assess their own and their team members' performance on the team tasks. In some cases, the peer evaluations are used in combination with individual student interviews to better understand the efforts of each team member. These evaluations may be given a percentage in the final grade allocation to encourage students to participate and provide feedback. The engineering design courses also use weekly project review sessions where instructors meet with teams to determine the division of work allocated to each team member and whether the team is progressing with the project in a timely manner. These sessions provide the opportunity for instructors to give feedback to students both on an individual and a team level. They also serve as formative assessments of each team member's contribution to the project deliverables as the instructor can orally examine the quality of the effort that each member is putting forth.

Determining Survey Items

The focus of the current study was to develop a tool for instructors, rather than peers, in order to provide an authentic assessment (Wellington, Thomas, Powell, Clarke, 2002) that could reflect the ways in which students may be assessed as engineers in the industry. As the engineering design courses in particular attempt to provide simulations of real-world problem solving, the research team considered this assessment as another way to help students align their educational experiences with the kinds of appraisals they may experience in their working lives. Additionally, although peer evaluations can provide a window into the team process, research indicates that students need to be sufficiently trained and have enough practice with peer evaluations in order to provide useful data (Brooks, Ammons, 2003). Students also tend to be more accepting of evaluations conducted by teachers, rather than by their peers (Macpherson, 1999).

In order to develop such a tool and its protocols for use, the team looked for performance indicators of teamwork that could be applied to courses at the PI.
During this search, we discovered the Team Developer instrument, which provides feedback on skills-based behaviors needed for success in engineering (McGourty, Dominick, Reilly, 1998). Although the primary purpose of the Team Developer is to provide feedback using a peer evaluation system, after reviewing the survey items, the team determined that a smaller set of items could be used as an instructor observational instrument. Initially, we chose 19 facets of team behavior to be observed, using a 4-point scale to determine level of observation (Not observed=0, Rarely observed = 1, Occasionally observed = 1, and Frequently observed = 3). However, after piloting these

items with two class sections, the team weighed the importance of the items with the ease of use of the entire instrument. As a result of the discussion, the observational tool was shortened to 12 behavioral items with a 3-point scale (Not observed = 0, Sometimes = 1, Frequently = 2). The survey can be seen in Appendix A.

The chosen items were then aligned with the teamwork component of the ADNOC employee performance criteria. The behavioral competencies for teamwork at ADNOC addressed (1) effective team performance, (2) participation in team meetings, and (3) ability to work in a multidisciplinary environment. Each of these components was met by at least two of the items in the observational tool.

Developing Observational Protocols

Once the research team agreed upon the behavioral items and assessment scale, three bilingual English/Arabic instructors were asked to observe team meetings in four course sections (two communications courses—one female, one male section; and two engineering design courses—one female and one male section). Although English is the medium of instruction at the PI, the majority of students have Arabic as their home language and often students will use a combination of English and Arabic to interact with each other. In order to ensure that the behavioral items are appropriate and observable in this context, the research team felt it was necessary to gain data for this study from instructors who can understand both languages. Observations were conducted by two instructors in order to assess the inter-rater reliability of the survey items.

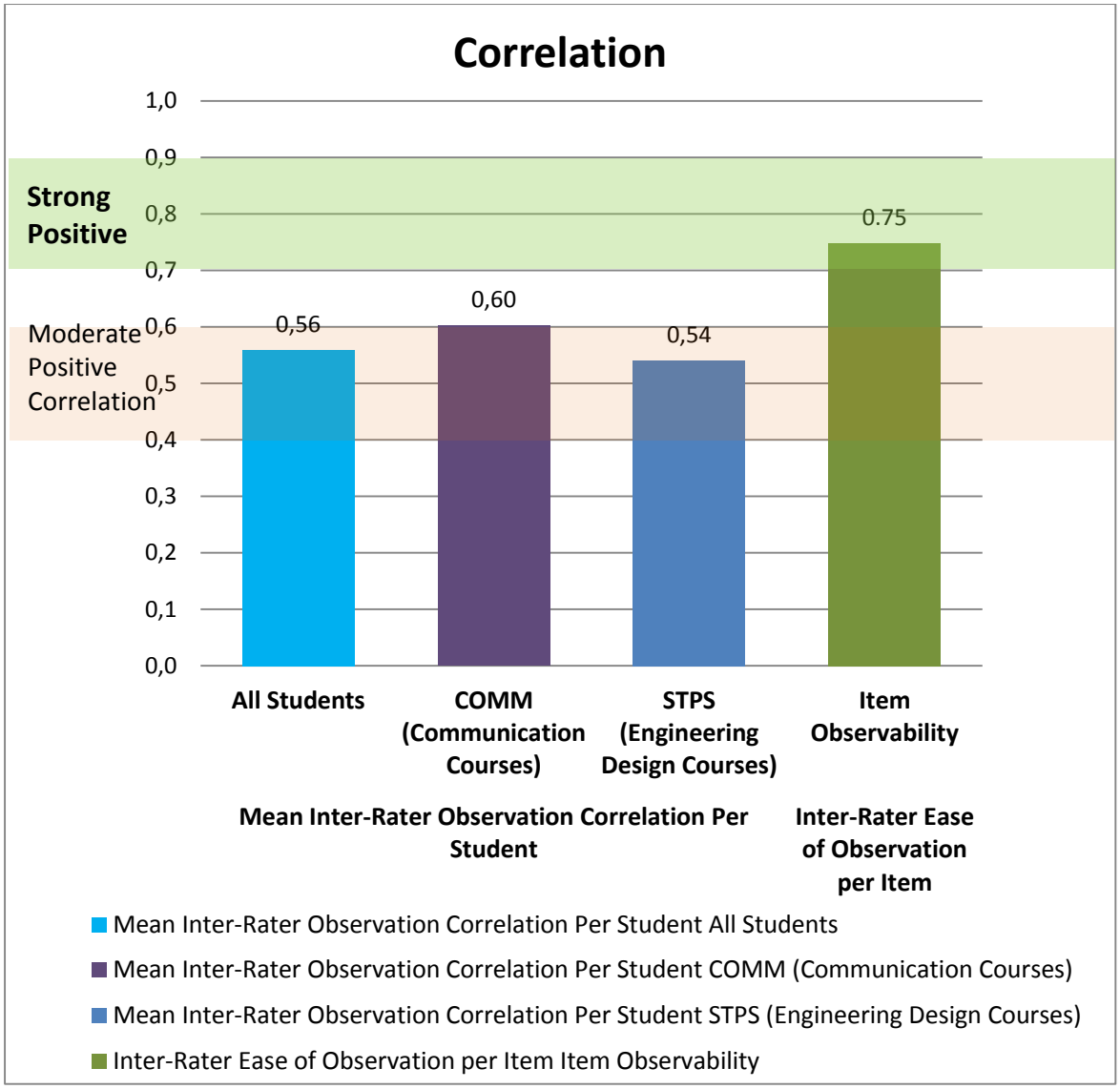
In each section, the two instructors observed team meetings for 20-25 minutes. A total of 57 students participated in the study, 32 females and 25 males. Teams generally consisted of 4-5 students, with one team in a communications section having 6 members. In three of the four sections observed, one instructor was the core instructor for that class, while the other was an outside observer who did not know the students. Although the observational tool is intended for classroom instructors, we also wanted to get qualitative data about its ease of use for observers who may not necessarily know the students and thus, would not have any preconceived notions or expectations of their behaviors. The teams in the two communications courses were evaluated by Observer 2 and Observer 3. The teams in the two engineering design courses were evaluated by Observer 1 and Observer 3.

Results

Inter-rater reliability was determined using Pearson's *r* correlations for behaviors for each student as observed by the raters. In general, the higher the correlation coefficient, the stronger the relationship between the variables. According to Dancey and Reidy (2004) a correlation between 0.7 and 0.9 is a strong positive correlation; a correlation between 0.4 and 0.6 is a moderate correlation; and a correlation between 0.1 and 0.3 is a weak correlation. The mean correlation of items for the complete set of students was 0.6, which indicates a moderate positive correlation between the raters on the behaviors observed for each student. In addition, the mean correlation of items for students in the two communications courses was 0.6 and the mean correlation of items for students in the engineering design courses was 0.5 (Figure 1).

We also looked at the ease of item observability among the raters. The overall correlation for ease of observability was 0.7 (Figure 1). For each rater, we ranked the items based on how many times these behaviors were observed in the sample. We then correlated the ranking of items across the two raters. In other words, among the raters, if the behavior was most difficult to identify by one rater, it was also the most difficult to identify by the other raters. The most difficult items to observe (the ones that were ranked lowest, thus observed the least by both raters) were items 2, 4, 8, 10, 11, and 12. Two researchers on the team separately considered all items and chose items 2, 4, 8, 10, and 12 as behaviors most likely to be exhibited by the team leader.

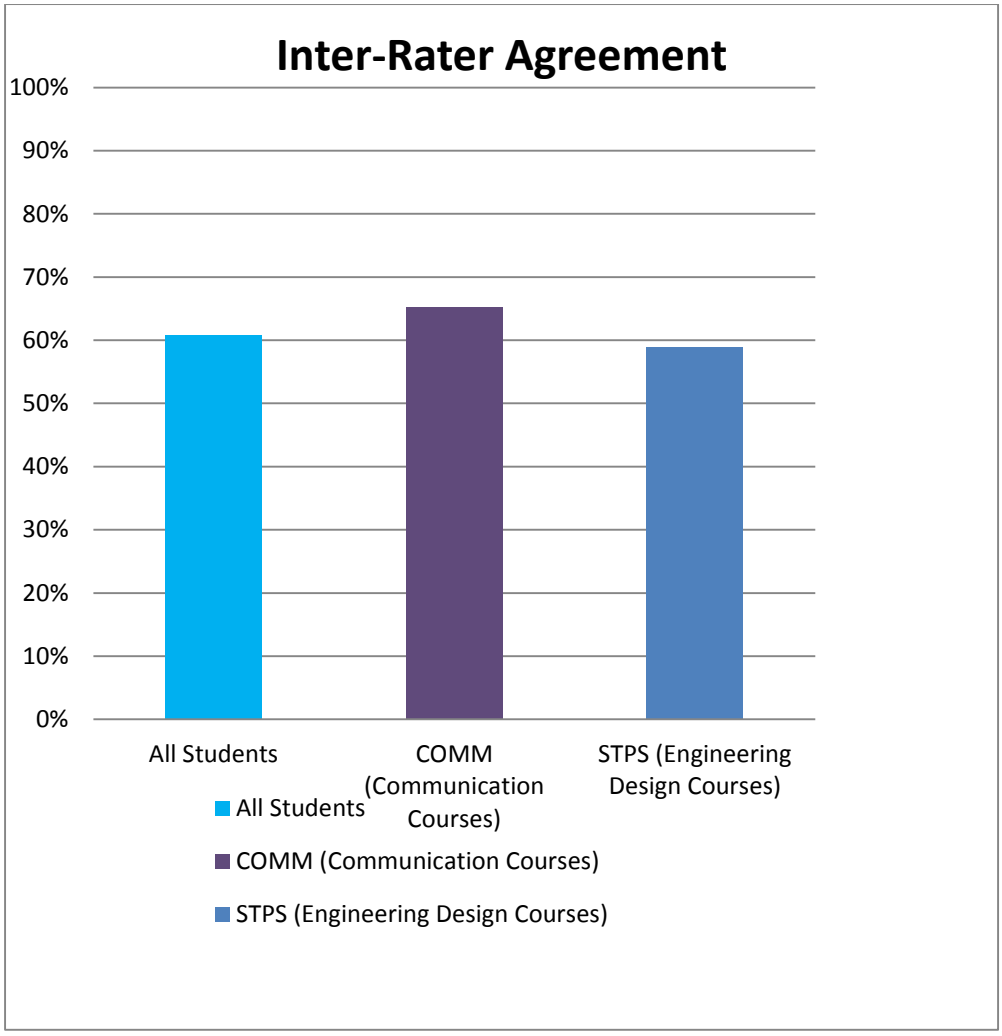
Figure 1: Correlations for Inter-Rater Reliability and Ease of Observation



Source: Own correlations based on data

Inter-rater agreement was further analyzed by comparing the ratings given to each student for each behavioral item by the two observers. For all students in the study, the mean rater agreement was 61%. This indicates that, on average, the two raters gave the same score for each student behavior 61% of the time. In the two communications courses, the mean rater agreement was 65% and in the two engineering design courses, the mean rater agreement was 59% (Figure 2).

Figure 2: Percentage of Inter-Rater Agreement



Source: Own calculations based on data

Interviews with the observers indicated that the survey was easy to use with the three observational categories. The core instructor (Observer 3) indicated that he felt more comfortable in the three observational sessions consisting of his students than in the one observational session with the students that he did not know. “It was easier to administer in my sections because I already knew the students, so I wouldn’t have to search for their names on the (rating) sheet. I also felt more comfortable assessing their behavior because I have some knowledge about the way they interact.” Observer 2, who did not know any of the students, noted, “I could handle a maximum of 4 – 6 students. I just watched them one by one. When the discussion got lively, I had to look at all the survey sheets.”

The observers, however, reported that not all items were applicable to each team member and that some behaviors were only displayed by team leaders. “I felt that not all questions apply to team members. For example, I thought questions 2, 4, 8 & 12 are more applicable to a team leader than all team members. Maybe you could have that set of questions specifically for the team leader” (Observer 1). “Some are leadership questions. Number 8 seems to apply only to a team leader or someone in a leadership role…Maybe it would be good to remove leadership-related items” (Observer 2).

The instructors also noted that the observational aspect may not necessarily capture the true interactions of team members as some students may feel like they are putting on an act for the observers. Observer 1 commented, “Students try to, but don’t always succeed, in acting like themselves. Their being conscious of the fact that we’re observing their behavior and interactions makes it feel unauthentic, especially when they know that the observing teacher understands each and every word they say.” Observer 2 remarked that the fluidity of the interactions depended on the team being observed: “One group we observed from a distance because we felt that they were intimidated or uncomfortable, you can say. The students worry about making mistakes, so sometimes, they’d rather not participate than make mistakes, especially if they don’t know the right term or vocabulary. Others didn’t care. So, it depended on the team.”

In terms of administering the scale, the instructors indicated that it would be important to conduct observations more than once to get a better understanding of the teamwork behaviors. “We have to watch the teams over time; otherwise, we’re only capturing what happens in one sitting and it may not reflect the actual behaviors of team members. Sometimes, people have a bad day, so if we don’t see them participating (the day of the observations), we end up thinking that’s how they always act.” (Observer 3) “By the time we finished observing the first two teams, the others were already done with the major parts of their discussions. I think the observations could be done over two or three classes in order to get a clearer and better picture of the behavior/interactions patterns in the teams.” (Observer 1)

Observer 2 and 3 also noted the importance of spending enough time with each team to allow instructors the opportunity to observe the behaviors. Observer 2 noted, “We can get a gist, but we need at least 15 – 20 minutes for observing (each team). Some teams need more time.” Observer 3 agreed, “Ten minutes is not enough. It’s difficult trying to watch all the students, especially if they start talking all at once.” They also felt that it would be important for the instructors who observe the teams to be able to understand Arabic in order to get valid data. Observer 2 stated, “Some groups discuss everything in Arabic. Only one group talked mainly in English. Most of them shift between English and Arabic. So, it may be difficult to understand the interaction if the observer does not understand

the language." Observer 1 agreed: "You can get some data if the instructor doesn't speak Arabic, but then the students will have to talk in English. This may make the interaction less authentic. You can get something, some information, but maybe not to the extent of someone who understands both languages."

Discussion

The current study was conducted to determine an effective and systematic way to assess teamwork behaviors of engineering students in a Gulf Arab university. The context of this study provides a unique lens into the educational environment of engineering students in a region of the world that is highly influential in the oil and gas industry. Items on the teamwork behaviors tool were taken from the Team Developer instrument (McGourty, Dominick, Reilly, 1998) based on their alignment with ADNOC standards and their ease of use.

The importance of having multiple observations during the semester was noted. As behavior can be dependent on the day of the observation as well as the content of the team meeting, team member behaviors should be observed on more than one occasion to ensure that members are given the opportunity to illustrate their teamwork skills. Multiple observations during a semester can also show growth of teamwork skills over time as well as allow students to become accustomed to the observational format. If observations become a regular part of the teamwork experience in the classroom, students may become less self-conscious, thereby allowing their behaviors to be more authentic and reflective of their teamwork practices. Observing from a distance may also help students in this regard. However, the chances of distraction may be greater depending on the vantage point. Finally, having regular observations of team processes can reduce shirking behavior as team members are aware that their contribution to the team is consistently being assessed (Marin-Garcia, Lloret, 2008)

For the current study, one observer was the core instructor for three out of the four sections observed. Although the observers felt that a minimum amount of time was needed with each team to get valid data on behaviors, the instructor who was the core teacher felt that it was easier to do observations with his set of students than with students he did not know. Other observers, however, felt that having prior experience with the students was not necessary. As the mean inter-rater agreement for the observations was 61%, it seems that knowing the student does not necessarily affect the observer ratings. However, it is possible that the ease of use for the instrument may be dependent on how familiar the observer is with the students being observed. As the tool is meant to be used by classroom teachers with their own set of students, it is likely that the tool will become easier to use as the semester evolves and instructors become more familiar with their

students. Once the survey is implemented in courses at the PI, further research can be conducted to determine its ease of use.

The rater agreement and reliability correlations were slightly higher in the communications course compared to the engineering design course. A number of factors could account for this difference, including the topic of the team meetings, the team member composition and the raters' knowledge of the course curriculum. Students in the communications course generally work on a more basic level compared to the engineering design course where team discussions require more technical language. As a result, outside raters who are not familiar with the course requirements may find it easier to observe students in the lower level course, thus making the rater agreement slightly higher for that course.

Observations for this study were conducted by bilingual English-Arabic speaking instructors. During the interviews, instructors noted the importance of understanding Arabic to improve the validity of the data. As many of the instructors at the university are not Arabic speakers, this may be a factor that limits the use of the current behavioral tool or any behavioral tool, for that matter. However, using an observational tool along with other measurement instruments can provide a more holistic view of teamwork, even if instructors are limited to assessing more non-verbal behaviors. As the language of instruction is English at the PI, students are accustomed to being asked to communicate in English for course-related tasks. Thus, even if instructors do not understand Arabic, they can still ask for clarification of verbal communication to get a better understanding of what is happening in the teams. Although asking students to communicate in English during team meetings may limit their interactions (especially among students who have a lower level of English language proficiency), this may be a worthwhile exercise to help students become more comfortable with English as the language of professional discourse at ADNOC. Given the large expatriate population in the UAE (Al-Jenaibi, 2011), students are likely to be working in multidisciplinary teams with international colleagues, making English the lingua franca. So, having an instructor that does not speak Arabic can simulate the norms that currently represent the engineering industry in the UAE.

The items related to leadership tended to receive the lowest observational ratings among the students. This is reflective of the fact that only team leaders would be likely to engage in leadership behaviors. This can be a useful tool then to verify if the designated team leader is the actual leader in the team. Thus, the use of leadership items can provide instructors with valuable information regarding the actual roles of team members versus the perceived roles and responsibilities. Collating the items that reflect leadership behaviors into a separate category in the survey may help instructors better identify the leaders.

One item (item 11) which was not identified as a leadership behavior was also ranked low in terms of ease of observability. The low ranking of this item may be related to the observational situation and type of behavior being discussed. Item 11 reads, “Accepts criticism openly and non-defensively.” As saving face is an important concept in Arab culture (Whiteoak, Crawford, Mapstone, 2006), it is possible that students would not want to engage in behaviors critical of their team members, especially in front of observers. As such, the usefulness of this item may need to be reconsidered.

Overall, the use of an observational tool for measuring teamwork can provide real-time information regarding the team processes while encouraging students to shoulder the responsibility for their project-based learning. By using team meetings as the vehicle for formative assessments, students can receive immediate feedback regarding their work and participation. In this way, students can move beyond independent learning to focus more on interdependent learning, where they can recognize their roles and responsibilities within the team and how their work affects others (Rugarcia, Felder, Woods, Stice, 2000).

Conclusion

Although the present study revolves around engineering students, the observation tool can be used to evaluate teamwork behaviors in any discipline. The tool adapts the competencies and behaviors of Team Developer, a peer evaluation system to help students improve their performance on the chosen teamwork criteria. In order to address the teamwork component of the introductory courses at the PI, the chosen items were used during authentic student team meetings to ascertain how individual team members performed. The observational tool provides another way to assess team member contributions and can be used alongside existing measures to improve the quality of student teamwork in university courses.

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Appendix A

Team Behavior Observation From

Team Name: ① ② ③ ④ ⑤ ⑥ Name: «Student_Name»
Student ID: «Student_ID» Course/Section: «Section»
Date of Team Meeting: March 26, 2015 Meeting # ① ②

Item	Never	Sometimes	Often
1 - Contributes ideas to the project	0	1	2
2 - Clarifies roles and responsibilities of others	0	1	2
3 - Listens attentively to others without interrupting	0	1	2
4 - Prioritizes tasks to ensure meeting project milestones	0	1	2
5 - Stays focused on the task during team meetings	0	1	2
6 - Uses meeting time efficiently	0	1	2
7 - Cooperates with others	0	1	2
8 - Encourages participation among all team members	0	1	2
9 - Contributes to the project's workload	0	1	2
10 - Encourages ideas and opinions even when they differ from his/her own	0	1	2
11 - Accepts criticism openly and non-defensively	0	1	2
12 - Acknowledges issues that the team needs to confront and resolve	0	1	2

Comments/Notes: (Optional)