Understanding Teaching Assistants' Assessment of Individual Teamwork Performance

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A team-effectiveness inventory of behavioural competencies was used as a conceptual framework with which teaching assistants were asked to assess each students' individual teamwork skills. The reliability and confidence of teaching assistant assessments as well as the way in which teaching assistants used these assessments to support students to become more effective team-members is presented.

1. Introduction

Team-based projects have become a common teaching practice in engineering courses as a means to simulate real-world environments and meet accreditation requirements for the development of teamwork skills[1]. In particular within design courses, team-based projects allow students to engage in problems that are technically more complex and larger than one student would be able to tackle, but that can be solved by a group of students working effectively together. In these courses, students are often instructed on the technical aspects of the project material in detail by the course instructor, however they may receive little or no instruction on how to function effectively as a team. Integration of team-effectiveness or teamwork skills into these courses in a manner that is applicable to the team-based project is necessary to achieve student buy-in that these skills are equally as valuable to learn as their technical counterparts. In particular, the ability to support and assess the development of team-member effectiveness is necessary in the classroom environment where instructors and/or teaching assistants work directly with these student teams.

The type of courses which this study aims to inform are integrated design and communication courses where students have minimal experience working in teams at the university level. At our University, courses like this can have from 250-1000 students, making teaching assistants (TAs) a valuable part of the instructional team. In these courses, instructors are often not present in the tutorial classrooms in which observations of teamwork are possible, removing their ability to assess the student development of team-member effectiveness. In addition to the TAs responsibilities to support the technical development of their students, the instructors rely on these TAs to identify any dysfunctional teams or team issues that may arise in their tutorial classrooms and for the majority of issues address them as well. With TA to student ratios at our university ranging from 1:12 to 1:30, the ability to identify and address these issues in addition to other classroom responsibilities can become challenging.

As a result of these demands on TAs, the assessment of student team-member effectiveness often falls to the students in the teams. Several online tools have been developed as platforms for students to develop and assess team-effectiveness competencies through the use of self- and peer-assessments (e.g. CATME[2], TeamDeveloper[3], WebPA[4]). These tools have primarily been designed to be plug-and-play type instructional tools that are designed to be dropped into any

team-based course and work with the team situation with minimal customization from the course instructor. These tools provide great resources to students who utilize them, and have been shown to identify teams which may be dysfunctional[5]. While studies have shown that the information from team assessment systems can enhance instructor assessment capabilities[6], few of the above systems integrate with the TAs who have to deal with several different team situations in their tutorials on a day-to-day basis. Studies into these tools' effectiveness as self- and peer-assessment instruments is well documented[7], however there is little on their utility in assisting TAs to assess student development of these skills.

TAs who support these design courses in tutorials are predominantly hired to assess student competence in, and support the development of, the technical or design components of their students' work. They are not necessarily capable of, or comfortable with, assessing students' abilities to work effectively in a team environment. In the medical literature, the assessment of technical and non-technical skills (such as teamwork) has shown to be assessed differently by students as compared to instructors. Greater convergence exists between instructor and student assessments in technical skills than in non-technical skills[8], with some instructors rating non-technical skills higher than student peers[9]. Whether this stems from less observation time with the students being assessed or from students being more relaxed in their behaviour around peers than instructors, medical faculty have argued that non-technical skills are more suited for self- and peer-assessment[10]. In business, a study of faculty and students at business schools has shown that faculty perceive there to be more team dysfunction in team-based projects than students do[11], indicating that students and instructors may be observing different markers of team functioning. Since the assessment need of technical and non-technical skills differ, TAs need to have clear frameworks as to how to assess these non-technical skills such as teamwork.

However, the way in which TAs can assess teamwork in tutorial situations varies drastically from the observational approach used in many behavioural assessments. In medical and pharmaceutical education non-technical skills (like teamwork) are assessed during clinical simulations. In these situations, the instructors are able to focus their entire attention on a single team's simulation without the need to support or respond to it during its execution[12]. However, in the design tutorial classroom, TAs are interacting with and observing several teams at once (upwards of six to eight), responding to student needs, and observing students' abilities to work effectively in teams. This cognitive demand is significantly greater for TAs than those documented in the behavioural assessment studies, and may result in differences between the behaviours a dedicated observer is able to assess, as compared to a TA. One approach researchers have undertaken to avoid this in-classroom assessment, is to video-record select intervals of team functioning and evaluate them outside of the classroom[13]. While this provides researchers with an understanding of the teams' functioning, it does not provide the TAs with any information on how to assess and adapt their teaching in real-time. Training to be an effective observer in this context is necessary.

In terms of TA training, much research has focused on developing the teaching skills of TAs. In design courses with team-based projects, TAs are often required to act as facilitators, adapting their teaching based on assessing the different needs of each team. Spike and Finkelstein[14,15] in their research on teaching/ learning assistant training programs in physics, have shown that training meetings and having teaching assistants complete a tutorial in advance of running it, converged teaching assistant awareness towards known student content difficulties and allowed

them to better identify and articulate these difficulties. In chemistry, the use of real-time behavioural rubrics in laboratories has allowed TAs to become more aware of student experimental skills and adapt their instruction to student need[16]. These behavioural rubrics were useful in this context as the TA to student ratio was 1:2, but in ratios much higher than this, it would not be possible for TAs to fill them out in real-time and respond to student needs simultaneously. One approach that could allow student assessment of larger classrooms is the use of behavioural checklists, such as those used to simultaneously assess technical and non-technical skills in medicine[17], which provide a binary assessment of the existence of observable behaviours. While this has potential for demonstrating weaknesses in terms of missing behaviours, it provides no scaffolding to enhance the performance of students who exhibit behaviours poorly. Minimal research exists into how TAs assess behavioural or non-technical skills in tutorial settings when provided with behaviours to observe and a rubric to complete post-hoc.

1.1. Study Objective

Over the past three years at our University, we have implemented the use of a Team-effectiveness Learning System to assist in the development of teamwork skills in student design teams. This system comprises two frameworks to define team effectiveness, a related self- and peer-assessment instrument with observable behavioural competencies, and on-line tools and techniques to assist students in improving upon their competency based on these assessments. This system is discussed in detail in the conceptual framework section of this paper, and in Sheridan's Team-effectiveness Inventory[18]. Our initial objective in involving TAs in the use of the assessment instrument was to provide a 'gold standard' by which to validate student self- and peer-assessments of their competence, but has led us to investigate how TAs attempt to assess individual team-effectiveness skills in their students.

This paper outlines a study of teaching assistants in a first-year cornerstone design course in an attempt to understand their ability to assess and support the development of individual team-effectiveness skills in their students. The study aimed to respond to the following research question:

> *How do TAs assess student teamwork using a conceptual framework for individual team-member effectiveness?*

The remainder of this paper will present the models of teamwork presented to students in the course and the conceptual framework of individual team-member effectiveness used in this investigation, followed by the study design, methods used, and results. The paper closes with key findings and implications for the assessment of student teamwork skills in design courses.

2. Design Course Context

The course in which this study occurs is a required first-year engineering design and communication course taken by 250 students at a large, public, research-intensive university. All students are part of a program in which their first two years are general, and their final two years are specialized. The course divides the students into 10 "studio" sections of 25 students, which are analogous to tutorials. A conscious language choice was made in the naming of this part of

the course so as to break students away from expecting the studios to follow a traditional tutorial model of a TA solving problems at the front of a classroom.

Students attended two hours of studio each week during a 13-week term. During studios, students work in teams of three or four on either their term-long design project or on specific concept development activities that will support their design project. During these studios, the role of the teaching assistants is to facilitate team-level or class-level discussions on course concepts, support individual teams in the development of their project work, and to engage in dialogue with students one on one to critique their team and project work so as to support their development as credible engineering designers. Teaching assistants move from team to team around the room, having conversations with each team at least twice during a typical studio.

Each studio was staffed with two TAs (forming a teaching pair), providing an instructor to student ratio of approximately 1:12. Each teaching pair staffed two or three studio sections per week, with teaching pairs held constant over the term. This allowed each pair to get to know the students and teams in each of their studio sections and to build rapport with them over the term. Each pair was comprised of one engineering TA with an engineering background and one communication TA with a background in the arts or humanities. These pairings were set up to ensure that the students were supported in developing their design and communication skills equally, to ensure the students practiced communicating their designs to non-engineers, and to model the multiplicity of perspectives that exist around the problems their designs aimed to address.

3. Team-effectiveness Frameworks

Two conceptual frameworks for team-effectiveness were employed in the first-year engineering design course studied. A team-level framework of teamwork comprising four models that describe how the team should work together was the foundation of team-level team effectiveness instruction in the course. This framework existed within the course before any individual-level team-effectiveness development was introduced. An individual-level framework of competencies that describes the behaviours of an effective team-member was the foundation of individual-level team effectiveness instruction in the course and the framework which was used by TAs to assess individual student's competence. This conceptual framework of individual team-member effectiveness will be referred to as the 'conceptual framework' for the remainder of the paper. The team-level framework is provided to give the reader insight into the team situation in the course, however it is not used in the analysis of the conceptual framework.

3.1. Pre-existing Course Framework of Effective Teamwork

The course already employed models of teamwork that were introduced to both students and teaching assistants in an interactive lecture-type format with specific examples to describe each of the components/stages of the models. The first model was Tuckman's model of team development[19] which was used as a way to describe to students the different types of actions and work they should undertake to form a high performance team. Components of Tuckman's model that were employed included discussing team norms and communication schedules, and determining the key design values the team would embody from individual's design values. The second model was Toulmin's model of argument[20] which was presented as a means of critiquing work and providing constructive feedback based on specific team encounters. This allowed

students to have a structured way to introduce issues they believed were creating problems, or critique other students' project-work in a manner that focused on the circumstances and beliefs of the presenter rather than the motives of anyone involved in the situation. The third model was the five dysfunctions of a team[21] which was used to demonstrate to students how teams fail when there is no trust between team members, and to dissuade the students from starting to think about their team project from the results perspective and instead to start thinking of it from a team building perspective. The fourth model was Johari's Window [22] which was provided to students as a means of developing their understanding of their self and how they are perceived by others. This particular model was the primary theoretical framework that was used to inform the integration of the conceptual framework of individual team-member effectiveness into the course; information gleaned from the use of this framework could be used to better inform the ways in which other students on their team perceived their behaviours and actions.

3.2. Conceptual Framework of Individual Team-member Effectiveness

The conceptual framework of individual team-member effectiveness followed in this paper is comprised of the 27 competencies outlined in a Team-effectiveness Inventory[18]. This inventory presents 27 competencies that comprise three aspects of individual team-member effectiveness: organizational aspects (project management), relational aspects (interpersonal relations), and communication aspects (information presentation and discussion) as shown in Table 1. These competencies are developed in students through the use of an online Team-effectiveness Learning System that allows students to complete and reflect upon self- and peer-assessments of their actions along these competencies. The inventory is comprised of a 7-point behaviourally anchored rating scale for each competency which describes what each of the competencies should look like in a team working at the 'performing' stage of Tuckman's model. Students can review their self- and anonymized peer-assessments as feedback in the on-line system and determine opportunities for improvement using the Johari's window concept and on-line lessons about each competency.

4. Study Design and Methods

This study involved teaching assistants (TAs) in a first-year cornerstone design course of approximately 250 students. The study aimed to determine how TAs assessed individual team-effectiveness behaviours when given a conceptual framework for assessment – the Team-effectiveness Inventory. The study took place in the winter term of 2012.

4.1. Study Participants

This study consisted of seven teaching assistants working as pairs across nine different studio sections that ran three in parallel on three different days of the week. Four teaching assistants staffed three sections per week, and three teaching assistants staffed two sections per week, creating five different pairs across the nine sections. All teaching assistants were in the process of completing either their Masters or Doctoral program in Engineering, the Arts, or the Humanities. Five of the seven TAs had worked as a TA for the course previously, with the two new TAs having completed the course as part of their undergraduate degree program; thus, all TAs had prior experience with the course. Four TAs were female, and all TAs were native English speakers. All TAs involved in the program participated in the study.

Table 1. The 27 competencies of the Team-effectiveness Inventory divided into the three aspects of team-effectiveness as presented in Sheridan's framework[18].

Organisational Aspects	Relational Aspects	Communication Aspects
O1. Support team rules	R11. Build the trust of teammates	C20. Exchange information in a timely manner
O2. Attend team meetings prepared	R12. Motivate others on the team to do their best	C21. Introduce new ideas
O3. Contribute to making meetings effective	R13. Raise contentious issues in a constructive way	C22. Openly express opinions
O4. Do their fair share of the work	R14. Solicit input before proceeding	C23. Promote constructive brainstorming
O5. Deliver their work on time	R15. Adopt suggestions from other members	C24. Actively listen to teammates
O6. Produce high quality work	R16. Accept feedback about strengths and weaknesses	C25. Provide constructive feedback
O7. Help to plan, set goals, and organize work	R17. Show respect for other teammates	C26. Make sure teammates understand important information and instructions
O8. Track team progress vs. your timeline	R18. Demonstrate accountability	C27. Help the team build consensus
O9. Encourage progress to meet goals and deadlines	R19. Collaborate effectively	
O10. Display dedication and determination		

4.2. Study Design

At the beginning of the course, teaching assistants participated in a 1.5 hour training session on teamwork and were invited to participate in the study. This training session comprised two objectives. First, it introduced the TAs to the course models of teamwork. TAs were introduced to what each of the competencies in the Team-effectiveness Inventory looked like at the high and low levels of performance through example team situations recounted from previous years. TAs were then provided a space to negotiate amongst each other working definitions of the terminology in the framework to ensure they were all assessing the behaviours in the same manner. Additionally, TAs had the opportunity to ask the designer of the inventory to clarify

each behaviour with examples of what the behaviour would look like in their course context. Second, TAs discussed high-functioning and dysfunctional teams from past years, indicators of dysfunction and strategies to support both types of teams in their development. In addition to this training session, TAs also attended the same lecture on teamwork that was attended by students, where the models were introduced and discussed in relation to students previous successful and unsuccessful team experiences.

During the final two weeks of the course, after the TA pair had been working with the students for eleven weeks, each TA was asked to independently assess the students in their studio sections on their teamwork ability using the Team-effectiveness Inventory. Assessments were completed online by the TAs on their own time during these final two weeks of the course. For each competency, TAs selected the student's behaviour along a 7-point behaviourally anchored rating scale, and were given a 'do not know' option in case they were unable to assess that competency. Following collection of all assessments, the seven TAs participated in a focus group to articulate their experiences providing assessments and to discuss how well this framework mapped to the team situation in the course and their perceptions of successful teamwork.

4.3. Analysis Methods

Using Creswell and Plano Clark's definition of mixed-methods research[23], this study aims to provide an explanation of how TAs assess student teamwork skills through combining their quantitative assessments of students' teamwork competency with follow-up qualitative discussions of how the TAs perceived and used the assessment instrument. Quantitative descriptive statistics were used to determine which competencies were most and least observable by the TAs in the tutorials. Inter-class correlations between TAs assessing the same students were computed, and confidence intervals for the reliability of TA assessment determined. Qualitatively, focus group transcripts underwent thematic analysis to determine the issues TAs had using the framework, discrepancies between the framework and the teamwork situation in the course, and how the framework assisted them in supporting student development of individual team-work skills.

5. How TAs assessed teamwork using the framework

Overall, TA assessments were 2-20% lower than student self- and peer-assessments, and had greater spread across all 7 options for each competency. TAs assessed an average of 16/27 (61%) competencies, with a low of 2/27 and a high of 27/27. TA frequency of response 'do not know' for each competency is shown in Figure 1, with competencies colour coded to distinguish the different aspects of individual team-effectiveness.

As can be seen from Figure 1, there is no general pattern in terms of TA ability to assess; TAs were able to assess all three aspects of individual team-effectiveness to a similar degree. In particular, there were 5 competencies in which TAs responded 'do not know' over 60% of time: *O8 - track team progress versus your timeline, R18 - demonstrate accountability, C20 - exchange information in a timely manner, C25 - provide constructive feedback, and C26 - make sure teammates understand important information and instructions.* These 5 competencies are highly related to the internal workings of the team which would not be visible in discussions in tutorials, or oral or written assignments. The 3 competencies in which TAs responded 'do not

know' less than 20% of the time were: *O3 - contribute to making meetings effective, R19 - collaborate effectively and C22 - openly express opinions.* These 3 competencies are all aspects that are not highly related to the internal workings of a team and would be visible to an outside observer watching the students work, or when interacting with a TA.

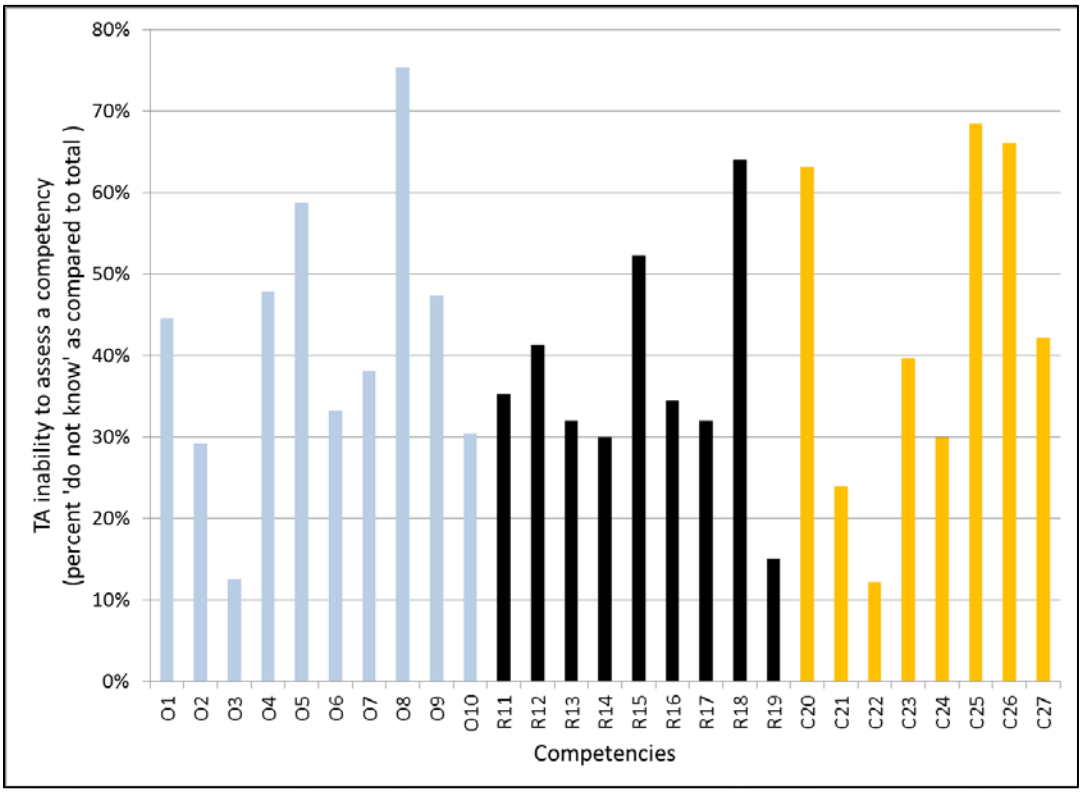

Figure 1. Percent of total assessments by competency that teaching assistants were unable to assess. For these assessments teaching assistants responded that they 'did not know' the student's competency. Abbreviated variable names correspond to the competency numbering provided in Table 1.

To determine the reliability of TA assessments when using the tool, the inter-class correlations (ICC) between the pairs of TAs were determined for each student. The students whose assessments were included were limited to those in which: 1) both TAs assessed at least 1/3 (9) of the competencies; and 2) both TAs demonstrated considered assessments, i.e. did not give the same assessment across all competencies. Forty-five percent of students assessed met these criteria and were used in this comparison. As can be seen in Figure 2, the average reliability between assessments is very poor, with a significant spread from high to no correlation. This can be understood well through the focus group data, where TAs discussed their difficulties in assessing individual team members. In particular, they found that teams which were neither high nor low performers, but were average were the hardest to assess, as less time was spent with these teams in the tutorials. Discussions with these teams also often focused on technical and design related material where students had the most questions, rather than on team dynamics. As a result, TAs discussed feeling less confident about their assessments of these teams. While grades data is unavailable to corroborate this finding, there was almost complete unanimity amongst TAs that this was likely the reason.

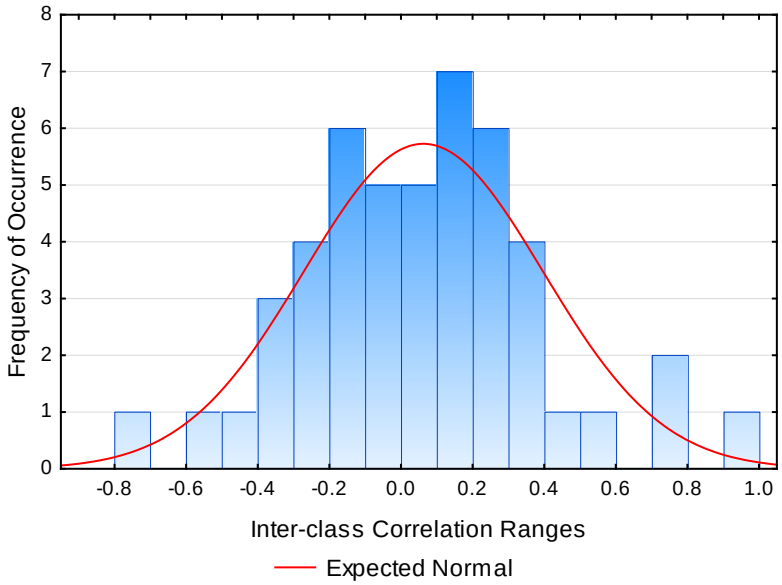

Figure 2. Distribution of inter-class correlation ICC(2,1) assessments for TAs.

In the focus group, TAs commented that this framework is better designed for use by team-members than by outside observers. As discussed above, some competencies were very difficult for an outside observer to assess as they required observation of aspects of team work that are not normally visible during a tutorial. In particular, given the limited time spent with the students and the types of interactions with the teams, TAs found it impossible to assess the competencies which they felt were vital to successful team performance, but were not visible in discussions with an outside observer. In particular, TAs felt least comfortable assessing the relational aspects of the framework as these competencies were not closely associated with any course content (in terms of material or presentation) and as a result TAs found it difficult to assess these on an individual basis unless the teams became dysfunctional. Additionally, TAs felt that the framework favoured extroverted and assertive students to the detriment of their team members. These students were the ones that the TAs felt most capable of assessing as they usually dominated the team discussions with the TAs and as a result were the students that the TAs knew most about.

The TAs felt that they were much better equipped and competent to assess the functionality of the teams as a whole rather than to assess individual students. TAs felt competent to address minor issues that surfaced in the teams regarding team dynamics, and at times where they did not feel equipped, they referred the teams to the course instructor for management. However, TAs did feel that as a result of the inclusion of the assessments in the course they were better able to identify dysfunctional teams faster, and provide the necessary supports to them sooner since they were consciously looking for these individual team-effectiveness behaviours. More often than not, TAs would provide their own advice on how to develop these behaviours based on past experience rather than based on the tools and techniques that were provided on-line with the framework. TAs commented that when you are in a classroom dealing with a question, such resources are not always accessible and that recommending them to the students at times is not as effective as providing a recommendation from personal experience.

Reflecting upon the use of the conceptual framework in the course, TAs agreed it was, in general, a useful tool. However, TAs felt that competencies around critical thinking, risk taking, and empathy were missing, while competencies around consensus building, input and feedback were overemphasized. Additionally, TAs felt that effective team-members in the course required self-awareness and the ability to acknowledge and work within their strengths and weaknesses but they did not see how this could fit into a teamwork assessment framework.

6. Conclusions and Future Work

This paper presents an initial study into the value of using TAs as outside observers to assess students' individual team-effectiveness behaviours given a conceptual framework of individual team-effectiveness. The assessments and feedback provided by TAs demonstrate that many of the competencies of the framework are not assessable by observers outside of the team, and that during normal tutorial work periods TAs are only able to assess the functionality of a team as a whole rather than the effectiveness of each individual team member. Resources to assist TAs in supporting individual team-effectiveness development that stem from the framework need to be more accessible in the classroom situation for TAs to make use of them.

Given that TAs may not be the most appropriate observers to assess individual team-effectiveness competence in the classroom setting, further investigations are needed to determine how to assess these competencies independently on an individual basis.

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