# AC 2009-2274: ASSESSING TEAM EFFECTIVENESS: COMPARING PEER-EVALUATIONS TO A TEAM EFFECTIVENESS INSTRUMENT

**Junqiu Wang, Purdue University**

**P.K. Imbrie, Purdue University**

P.K. Imbrie is an Associate Professor of Engineering in the School of Engineering Education at Purdue University. He teaches first-year engineering courses as well classes in Aerospace Engineering. His research interests include: epistemologies, assessment, and modeling of student learning, student success, student team effectiveness, and global competencies; experimental mechanics; and piezospectroscopic techniques.

# Assessing Team Effectiveness: Comparing Peer-Evaluations to a Team Effectiveness Instrument

**Keywords: Team Effectiveness, CFA, Peer-Evaluation**

**Abstract**

Engineering education continually increases the use of academic teams for active and cooperative learning. According to ABET, engineering students should be able to function effectively within a multidisciplinary team. Moreover, current engineering practice in industry requires effective team cooperation. Thus being able to function in a multidisciplinary team entails both academic and industrial importance.

Team effectiveness has been studied extensively in industrial settings. Many factors that contribute to the team effectiveness have been studied thoroughly. Factors including interdependency, potency, and goal setting have been identified as highly related with team effectiveness.

This paper addresses the validity of our team effectiveness scale through cross-validation process. In order to do so, we developed a 9-item Likert self-assessment peer evaluation scale to measure how individual evaluate their peer teammates as effective or not. Psychometric analysis results are used to demonstrate reliability of the data sets. Cronbach's coefficient alpha is higher than .90 for both the peer evaluation scale and the team effectiveness scale. Confirmatory Factor Analysis (CFA) is used to verify the theoretical structure of the peer evaluation and team effectiveness factors using LISREL. CFA results show there is a positive correlation between the team effectiveness measured by the two scales, thus we concluded that our team effectiveness instrument proved to be valid through the cross-validation process.

## Background

The Accreditation Board for Engineering and Technology (ABET) [1] with Engineering Criteria 2000 started a movement to advance the current curriculum and pedagogy of engineering education. According to ABET guidelines, students graduating from engineering programs should not only have strong traditional engineering knowledge in fundamental areas such as mathematics and science, but should also be able to work effectively in a multidisciplinary environment in multicultural teams.

Campion, Medsker, and Higgs [2] define team effectiveness in terms of productivity, employee and customer satisfaction and manager judgments. Based on this hypothesis, they found that potency and interdependency are among factors described as important attributes of an effective team through the study of real teams in the field. Guzzo [3] defines team effectiveness through group-produced outputs and the capability to perform well in the future. O'Leary-Kelly, et al. [10] proposed that goal setting has a strong effect on effective team performance through meta-analytic approach. After reviewing many laboratory and field studies on the effects of a task, Locke et al found that specific and challenging goals setting contributes better performance [9]. Imbrie et al. [4] operationalized team effectiveness through interdependency, potency, goal setting and learning.

**Theoretical Model**

Imbrie [4] reported results of an analysis of a four-factor model to study team effectiveness of student teams in real academic setting. A 24-item Likert team effectiveness scale was developed to measure the following four factors: interdependency, potency, goal setting and learning. In Imbrie's study, a confirmatory factor analysis results show the four factors model provides no better fit than a one-factor model. In this study, we look at three factors of the four-factor model interdependency, potency and goal setting, this corresponding to 19-item Likert team effectiveness scale.

The analysis in this report is based on a three factor team effectiveness model. We have developed two instruments for this study. The first is a 19-item questionnaire instrument measuring a student's perception about his/her team's overall performance in the three factors of the team effectiveness, as shown in Table 1. The latent variable expressing the student's perception of their team's overall performance is designated as TETEAM. In Table 1, items starting with IN, GS and PT correspond to interdependency, goal setting and potency measurement respectively. All items are in a 5-item Likert-scale from Strongly Agree to Strongly Disagree.

**Table 1: Team effectiveness items for measuring a student's general experience on how effective they found their team experience (designated as TETEAM)**

| Items | Description--Interdependency |
|---|---|
| IN01 | My team collaborated effectively to complete our assignments. |
| IN10 | My teammates displayed appropriate interpersonal skills when conflict arose. |
| IN02 | My contributions to the team were appreciated by each teammate |
| IN03 | I had confidence in each team member to contribute his/her fair share of what was required. |
| IN04 | My team used a process/method (e.g., code of cooperation) to hold each member accountable. |
| IN09 | Team members were prepared for team meetings. |
| IN08 | Team members arrived on time to team meetings. |
| IN06 | An outside observer would have concluded our team had an effective process to complete our assignments |
| IN05 | At any particular time, I knew what each member of my team's role was so I knew what to expect from them. |
| PT01 | My team was confident in its ability to overcome adversity (e.g., interpersonal conflict, assignments). |
| PT02 | I feel a sense of accomplishment in my team's ability to work together. |
| PT03 | This team gave me confidence in the ability of teamwork to solve problems. |
| PT04 | My team had the collective abilities (e.g., communication, interpersonal, technical) to accomplish course assignments. |
| PT05 | I was confident that our team produced acceptable solutions to course assignments. |
| GS02 | My team used clear, long term goals to complete tasks. |
| GS03 | My team reflected upon its goals in order to plan for future work. |

| | |
|---|---|
| GS04 | My team made use of incremental goals (i.e., we set short term goals) in order to complete course assignments on time. |
| GS05 | My input was used to set our team goals. |
| GS06 | This team helped me accomplish my individual goals for this course. |

The second questionnaire is a 10-item Likert-scale peer evaluation instrument developed to measure three team effectiveness factors based on how a student evaluates each individual on his/her team. Among the 10-item Likert-scale peer evaluation, there is one single item on its own dedicated to measure the general opinion of each specific team member on their whole team effectiveness is designated TECT. The team effectiveness measured by the 9-item is designated as TEPEER. The team effectiveness from the one general team effectiveness in the peer evaluation instrument is designated as TECT. The detailed list of the items is shown in Table 2. Constructs are labeled I, G and P, representing interdependency, goal setting and potency, shown as the last letter of "Item ID" in Table 2.

**Table 2: Peer evaluation items for measuring how a student evaluating their peers.**

**9-items within TEPEER:**

| Item ID | Item Description |
|---|---|
| CI021I | Collaborates well with my team on all in-class and out of the class assignments. |
| CI022I | Contributes to my team's effectiveness by having a clearly defined role(s). |
| CI023I | Is a reliable team member. |
| CI024G | Often helps my team think of what we were/were not achieving. |
| CI025G | Articulates individual goals that can be achieved with the help of my team. |
| CI026G | Actively helps my team establish goals. |
| CI027P | Helps my team to build a shared confidence in its ability to successfully work together on course assignments. |
| CI028P | Often encourages each team member to believe in my team's ability to succeed no matter what the task. |
| CI029P | Often makes my team feel confident in its ability to resolve disagreements. |

**Single item designated TECT:**

| | |
|---|---|
| CT1 | Overall, I would consider my team to be highly effective. |

In this study we try to investigate the validity of our team effectiveness scale through a cross validation process. The research question of this study: is the team effectiveness scale valid through cross-validation process?

**Methods**

Participants of this study include 879 freshmen engineering students at a large Midwestern University. The population consists of students that are 22.6% female, 77.4% male. All students are enrolled in the same first year engineering course. Students were assigned to a permanent team consisting of 3 or 4 students through the entire semester working on course related projects. The team was formed by taking into account of student's background diversity. The self/peer evaluation questionnaire (TEPEER, TECT) was given to students after finishing their first project as a team. The team effectiveness instrument questionnaire (TETEAM) was given to the students immediately after they completed the self/peer evaluation.

The team effectiveness instrument was designed to identify whether a student perceived their team as effective. The peer evaluation scale was designed to identify how the students evaluated their individual teammates. The hypothesis is that the student's perception of their individual teammates should be highly correlated with the students' perception of their teams' effectiveness. Since students work within teams of 3 or 4 members, he/she will provide 3 to 4 peer evaluation scores including him or herself. The average score of a student giving to every individual of the team (including himself/herself) for each item is used to represent the score a student's peer evaluation score.

**Data Analysis**

The basic statistics of the 19 items in the team effectiveness scale are shown in Table 3 in the right-hand column with the 10 item peer evaluation scale in the left.

**Table 3: Basic statistics of the data**

| Item ID | Mean | Std Dev |
|---|---|---|
| CI021I | 83.70 | 11.56 |
| CI022I | 79.77 | 14.85 |
| CI023I | 87.02 | 11.29 |
| CI024G | 80.61 | 12.87 |
| CI025G | 79.01 | 15.06 |
| CI026G | 80.96 | 12.86 |
| CI027P | 80.33 | 13.51 |
| CI028P | 78.51 | 14.98 |
| CI029P | 79.07 | 14.75 |

| Item ID | Mean | Std Dev |
|---|---|---|
| GS02 | 3.97 | 0.90 |
| GS03 | 3.84 | 0.87 |
| GS04 | 4.04 | 0.84 |
| GS05 | 4.29 | 0.71 |
| GS06 | 4.17 | 0.84 |
| IN01 | 4.42 | 0.73 |
| IN02 | 4.27 | 0.71 |
| IN03 | 4.19 | 0.90 |
| IN04 | 4.02 | 0.85 |
| IN05 | 3.96 | 0.87 |
| IN06 | 4.12 | 0.84 |
| IN08 | 4.13 | 0.86 |
| IN09 | 4.29 | 0.79 |
| IN10 | 4.30 | 0.79 |
| PT01 | 4.36 | 0.77 |
| PT02 | 4.23 | 0.84 |
| PT03 | 4.20 | 0.81 |
| PT04 | 4.31 | 0.74 |
| PT05 | 4.38 | 0.71 |

Cronbach's coefficient alpha can be used as an indication of the reliability of a data set [5]. The Cronbach's alpha for the constructs of interdependency, goal setting and potency for team effectiveness scale data sets are, 0.94, 0.90, 0.93, respectively. The Cronbach's alpha for interdependency, goal setting and potency for peer evaluation scale are 0.89, 0.94 and 0.97, respectively. The Cronbach's alpha for two combined scales are 0.96 and 0.97 for team effectiveness and peer evaluation respectively, which exceeded the desired criteria of 0.90 [6]. The Cronbach's alpha value showing above for both scales indicates strong internal reliability of our data. (describing the FIE paper, that study was not replicated from the previous paper)

Confirmatory Factor Analysis (CFA) was conducted using LISREL 8.80 [7]. Unweighted least squares were selected for parameter estimation. Fit parameters used to assess the fit of the model include the chi-square statistic, Root Mean Square Error of Approximations (RMSEA), and Goodness of Fit Index (GFI). RMSEA indicates the amount of unexplained variance or residual with values equal to or less than .05 indicating good model fit and values less than .08 indicating reasonable fit [12]. GFI provides the amount of variance and covariance in the sample covariance matrix accounted for by the implied model with a value range of 0 to 1 with the value higher than 0.95 indicating acceptable fit [13]. The probability of rejecting a good model increases as the sample size increase using the chi-squared statistic [11], so for this study, the model fit is assessed using only the values for GFI and RMSEA.

**Results and Discussion**

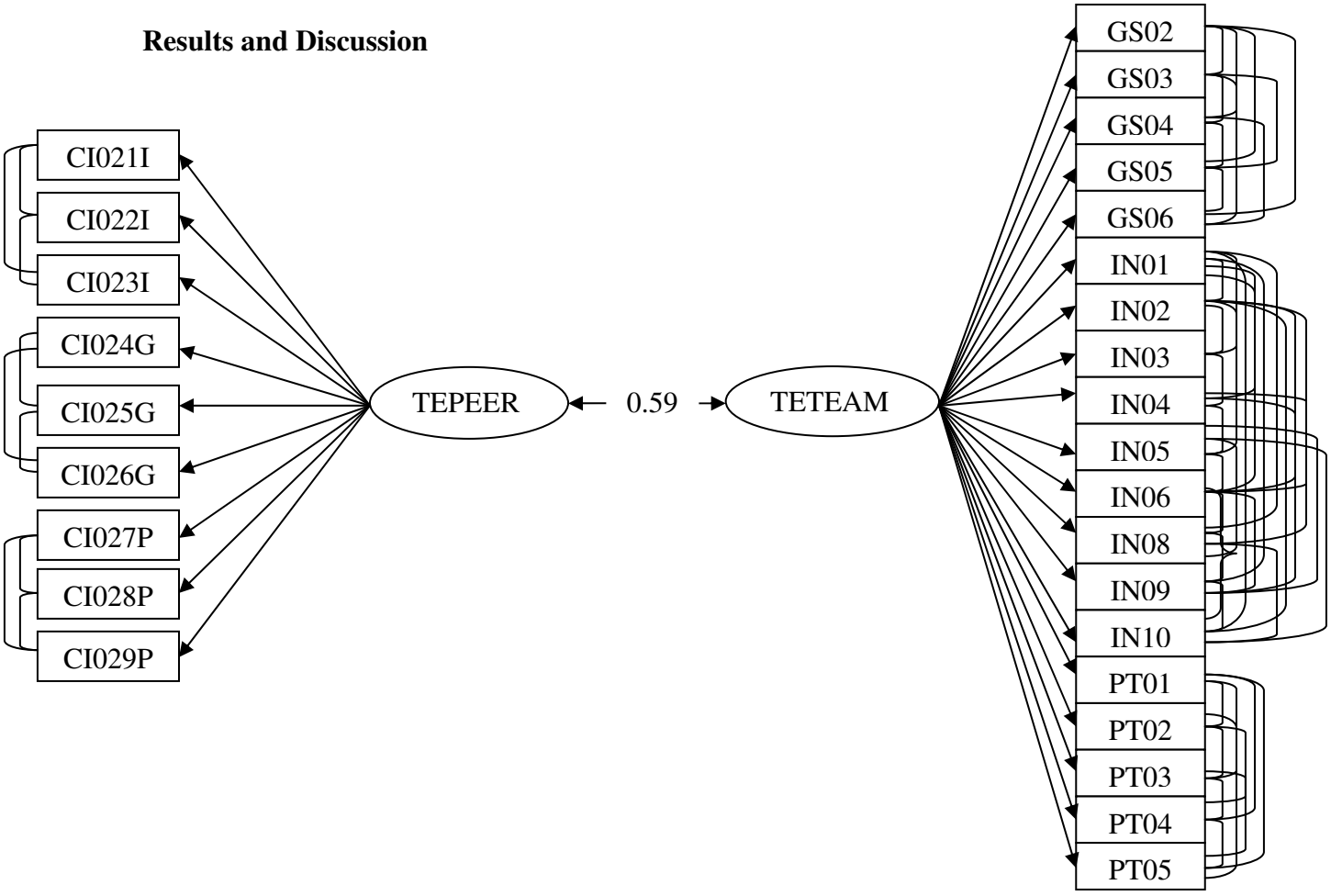


**Figure 1: Path diagram of peer evaluation items and team effectiveness items**

In this study, there were three theoretical correlations of interest. The first correlation is the correlation between team effectiveness measured from 9-item peer evaluation instrument TEPEER, with the team effectiveness explained by the 19-item team effectiveness instrument TETEAM, as shown in figure 1. In figure, the items belonging to the same sub-factor are connected. For example, every item from potency are correlated with each other. The second is

the correlation between the 9-item peer evaluation team effectiveness construct TEPEER with the single item peer evaluation team effectiveness TECT, as shown in figure 2. The third one is the correlation relationship between team effectiveness explained by the single item in the peer evaluation construct TECT and the 19-item team effectiveness construct TETEAM, as shown in figure 3.

Figure 1 shows that the correlation coefficient between TEPEER and TETEAM is 0.59. According to Cohen [8], correlation coefficients between 0.5 to 1 indicate a positive correlation relationship, thus 0.59 indicates a positive correlation between the two independent variables TEPEER and TETEAM. The GFI value is .99 and the RMSEA value is .064 which indicates an acceptable fit. The positive correlation between the two variables means that self report peer evaluation can be used to predict the team effectiveness to a certain level.

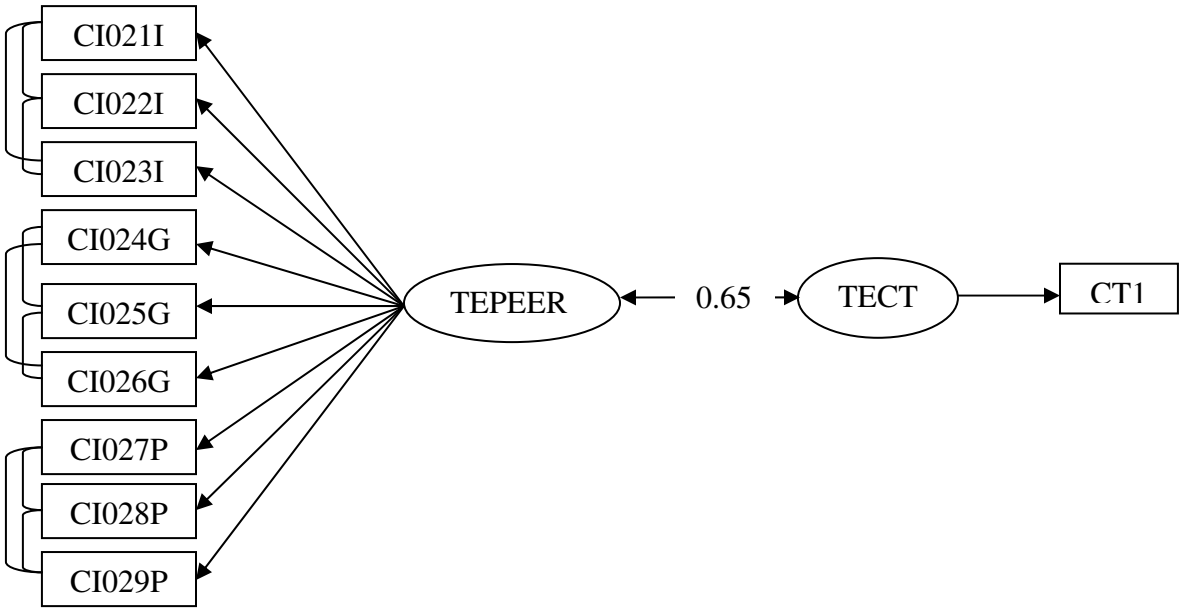


**Figure 2: The correlation between peer evaluation items and self-report item on team effectiveness**

The correlation coefficient between TEPEER and TECT is 0.65, as show in figure 2. The goodness of fit value is .99 and RMSEA value is .081. The RMSEA value is very close to 0.8, which indicates an acceptable fit. We can conclude that the 65% of variance from TEPEER can be explained by TECT.

**Figure 3: The correlation between 19-item team effectiveness with the one item team effectiveness from peer evaluation**

The third correlation of interest in this study is the correlation between latent variable TECT predicted by a single item of student's perceptions of his/her team effectiveness in the peer evaluation with the latent variable TETEAM predicted by 19-item team effectiveness instrument. The correlation between TECT and TETEAM shown in figure 3 is 0.62, indicating the two latent variables having a positive correlation. GFI value is .99 and RMSEA value .081 indicates our data adequately fits our theoretical model structure.

**Conclusion**

Confirmatory factor analysis results demonstrated that the structure of the models as presented adequately fit. The three team effectiveness measured by the self-report peer evaluation scale and the team effectiveness scale are all inter-correlated which show that our instruments are valid in measuring team effectiveness. The psychometric analysis confirmed the validity of our data sets with Cronbach's alpha values as large as 0.9.

First year students have very little experience in evaluating their peers, thus there is a strong possibility of bias in their evaluation. They might give a higher score for overall team performance or they might also provide lower score to their individual teammates at the same time. For example, consider a team composed of 4 members in which reasonable goals are set and a high quality output is delivered, but comprised of students working as individuals with little interdependency. In this case, student doing peer evaluation of team effectiveness may give higher scores for all aspects of the team performance since students could not distinguish between interdependently from other team effectiveness aspects. A modified model will be studied by considering the possible bias based on student's inability to identify individual characteristics of an effective team clearly.

**Acknowledgments**

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