

2006-1442: THE QUALITY OF SOLUTIONS TO OPEN-ENDED PROBLEM SOLVING ACTIVITIES AND ITS RELATION TO FIRST-YEAR STUDENT TEAM EFFECTIVENESS

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The Quality of Solutions to Open-Ended Problem Solving Activities and its Relation to First-Year Student Team Effectiveness

Abstract

ABET requires that engineering graduates be able to work on multi-disciplinary teams and apply mathematics and science when solving engineering problems. One manner of integrating teamwork and engineering contexts in a first-year foundation engineering course is through the use of Model-Eliciting Activities (MEAs) – realistic, client-driven problems based on the theoretical framework of models and modeling. This study looks at the quality of eleven student team solutions to a Model-Eliciting Activity and their team effectiveness, specifically interdependency (cooperation among team members to accomplish a task), goal-setting (team sets outcome goals and sub-goals to accomplish tasks), and potency (shared belief among team members that they can accomplish their goals).

Background

The National Research Council Board on Engineering Education, NSF Engineering Education Coalition Program, and the Accreditation Board for Engineering and Technology¹ Engineering Criteria 2000 have been instrumental in driving the reform of engineering education. ABET places particular emphasis on graduates having the ability to work on multi-disciplinary teams and apply mathematics and science when solving engineering problems¹. Even with the added importance of the use of student teams in engineering, there have only been a few research studies that attempt to measure team effectiveness². The work presented here defines team effectiveness based upon “industry” type teams. According to Guzzo³: *A team is a group that consists of individuals who see themselves and are seen by others as a social entity, which is interdependent because of the tasks performed as members of a group. They are part of the educational process, performing tasks that affect both individual and group learning.* One of the main differences between a “team” and a “group” is that individual team members are *interdependent*, meaning that the team must have cooperation among team members to accomplish a task³. Along with *interdependency*, the other attributes of teams are *potency*, the shared belief by a team that they can be effective⁴ and *goal setting*, the ability of a team to set goals and sub-goals to accomplish a task⁵. By working cooperatively using teaming theory as a guide for skill development, students can be motivated toward the goal of performance on problem-solving tasks⁶. This study measures the quality of student team solutions to complex problem solving tasks as it relates to their team effectiveness with regards to interdependency, potency, and goal setting.

Implementation

Setting

The setting for this study is a required first-year introductory engineering course at Purdue University that focuses on engineering computer tools such as MATLAB and Excel, fundamental engineering concepts, and problem solving. Successful completion of the first-year

engineering course calls for students to develop a logical problem solving process which includes sequential structures, conditional structures, and repetition structures for fundamental engineering problems; translate a written problem statement into a mathematical model; solve fundamental engineering problems using computer tools; and work effectively and ethically as a member of a technical team. One approach to having first-year students solve open-ended problems is through team-oriented tasks called Model-Eliciting Activities (MEAs). These tasks are based upon the models and modeling perspective put forth by Lesh and Doerr⁷ and are developed using six design principles⁸⁻⁹. The National Research Council's Board of Engineering Education recommends ensuring "early exposure to engineering practice and a sense of the role of the engineer in society"¹⁰. In the first-year engineering course, MEAs are being used as a vehicle for conveying the nature of engineering and engineering practice to first-year students, as well as demonstrating the usefulness of functioning on technical teams in realistic situations.

The Accreditation Board for Engineering and Technology¹¹ states in Criterion 3d that students must demonstrate "an ability to function on multi-disciplinary teams." For this reason, the first-year engineering course is designed to use teams extensively throughout the semester. Early in the semester, students learn about characteristics of effective teams such as interdependency, goal setting, roles and norms, cohesiveness, and communication. The students participate in team and peer evaluations of their teaming experiences and create team specific codes of cooperation that guide team functioning.

Model-Eliciting Activities Overview

Model-Eliciting Activities are open-ended, client-driven, realistic problems that require teams of students to solve them. These authentic assessment¹² tasks are complex, open-ended problems set in a realistic context with a client. Solutions to MEAs are generalizable procedures which reveal the thought processes of the students. The activities are such that the students work in teams of three to four students to express their mathematical model, test it using sample data, and revise their procedure to meet the needs of their client. The framework that guides the development of MEAs is based on six design principles. The theory behind these design principles has its root in engineering design. Lesh, et al.⁸ and Diefes-Dux, et al.⁹ offer more information about these design principles.

The format of a Model-Eliciting Activity is such that the students are first introduced to the context through an advanced organizer. In this case, an advanced organizer is a memo from the client that helps students enter into the problem. The organizer includes questions to help students individually begin to think about the situation in which they are being placed or assist them in organizing their mathematical understandings in a manner that will be advantageous to them as they work on the engineering task. Moore, et al.¹³ and Diefes-Dux, et al.⁹ provide more information about the framework and development of these team activities.

The problem statement introduces students to the task. It is written in such a way as to make the students define for themselves the problem a client needs solved. The students must assess the situation to create a plan of action to successfully meet the client's needs. The problem solving session requires that a group of students go through multiple iterations of testing and revising their solution to ensure that their procedure or algorithm will be useful to the client⁸. By carefully crafting each MEA, students are given just enough information to make informed

decisions about when the client's requirements have been met. One of the main differences between this type of task versus typical engineering problem solving activities is that most traditional problem solving activities are focused solely on the creation of a physical product; whereas, MEAs are directed at the development of procedures or processes for solving the problem⁹.

Due to the nature of the problem statement, teams of students solve the problem to meet the client's needs. The teams are necessary for two reasons. First, there is a time constraint on the solution of the problem. Therefore, students do not have the luxury of mulling over the task for hours to think of things they might have missed. By requiring multiple perspectives, the teams come to better solutions in less time¹⁴. Also, engineers working in industry often must rely on the expertise of team members to complete tasks assigned to them. Being able to effectively work in teams is not a skill that most people automatically possess. Therefore, it is necessary to put students in situations where it is essential to work in teams to allow them to develop teaming skills¹⁵.

Factory Layout MEA

The Model-Eliciting Activity that will be discussed throughout this paper is called *Factory Layout* and was the first of four MEAs first-year students completed during the fall semester of 2005. An abbreviated version of the *Factory Layout* MEA is shown in Table 1. The MEA was completed in a computer laboratory setting with the students working both individually and in teams of 3 to 4 students. The students had twenty minutes to do the individual portion and one hour to complete the team portion of the MEA. The students begin by reading the entire MEA individually. When students work this problem, the individual warm-up activity (the last section of Table 1) requires that the students think about the problem and provides the students time to organize their thoughts before setting out to solve the problem with their team members. The student teams then re-read the problem statement and develop the model for their procedure.

Table 1. Factory Layout MEA

Problem Statement	
TO:	PLANNING AND DEVELOPMENT TEAM
FROM:	CAMERON MARTIN, GENERAL MANAGER, INDUSTRIAL PLANNING INC
SUBJECT:	NEW SITE DEVELOPMENT
DATE:	9/7/2005
<p>Your team has been hired as consultants to aid in site planning and development for our various clients. One of our clients, Tube Alloy Inc., contracted us yesterday. Tube Alloy is based in Ljubljana, Slovenia and is a supplier of extruded aluminum products in Eastern Europe. They are looking to expand into the US market. This client is looking to purchase existing facilities in the US for production of bike frames, hydraulic tubing, and vehicle drive shafts. They are considering purchasing several sites and have contracted us to develop a process to facilitate equipment layout with the goal of minimizing the distance that materials in production have to travel between departments within the plant.</p> <p>Tube Alloy's facilities require three (3) production departments: extrusion, heat treatment, and shipping/receiving. Each plant also needs office space. The client has stipulated that a facility must be roughly 122,500 ft², so for simplicity assume potential sites are 350 ft on a side and square (350 ft x 350 ft = 122,500 ft²).</p>	

Shown below is a table of the square footage or “footprint” required and limiting aspect ratio for each of Tube Alloy’s departments.

Department	Area	Limiting Aspect Ratio*
Office	10,000 ft²	3:1
Extrusion	40,000 ft²	4:1
Heat Treat	10,000 ft²	1:1
Shipping and Receiving	25,000 ft²	4:1

*The limiting aspect ratio refers to the shape of the footprint. 1:1 is a square, while 3:1 (for example) is a rectangle with the long side being 3 times the length of the short side. The aspect ratio provides an upper limit on how elongated a footprint can be. The lower limit for all equipment is a square, or a ratio of 1:1.

Notice the total of the department areas is not 122,500 ft²; there needs to be extra space for forklifts and other mobile equipment to move around equipment and between departments. All materials are moved by forklift-type equipment between departments. A 25-foot wide pathway is required between all departments. The most important factor to consider when you are laying out the plant is the distance materials have to move from one department to another. This distance must be minimized. Distance between departments is measured from the geometric center of each department.

The client wants two things: (1) a process for determining optimal plant layout in a square plant and (2) a sample layout of a plant that includes the necessary production and office space departments in a square 122,500 ft² space. More data is coming soon from Tube Alloy about the specific equipment that they will have in the plant. For now, just concentrate on the placement of the four departments. I have included the processing steps required for each item Tube Alloy manufactures. Notice that they are not the same; each product has a separate order of processes to make a finished product. You must take all three products Tube Alloy, Inc. makes into account when designing a floor plan. Your method for placement of departments must minimize travel distance to finished product.

In a memo to the client provide:

- A reusable procedure that Tube Alloy, Inc. can use “in-house” to determine optimal placement of the production and office space departments for any square plant. Clearly state the reason for each step, heuristic (i.e. rule), or consideration in your procedure. As the company plans to open several plants in the coming years, a procedure is desirable to improve efficiency in establishing layouts for plants with different department dimensions and overall plant size.
- A sample 122,500 ft² plant layout that takes spatial concerns into account. The layout should be drawn within the square grid provided.
- Total distance of material travel for each product for your team’s final plant layout must be provided to the client in the memo.
- Final department dimensions must also be provided in the memo to the client.

Good luck. Let me know if your team runs into problems.

Cameron Martin

Tube Alloy, Inc. Production Information

Tube Alloy, Inc. manufactures three products. Table A lists, in order from start to finish, the departments that the materials must flow through to produce the final products. The actual processing step is also provided. Notice that materials in production will travel back and forth between the various departments before they are complete. Use this information to organize the plant layout to minimize material transit distance between departments. Note that departments must contain all associated processing equipment; they cannot be broken up into pieces and scattered throughout the plant.

Table A. Sequence of departments (processing steps) for Tube Alloy Inc. products.		
Bike Frame	Hydraulic Tubing	Driveshaft
Shipping and Receiving (Raw Material)	Shipping and Receiving (Raw Material)	Shipping and Receiving (Raw Material)
Extrusion (Press)	Extrusion (Press)	Extrusion (Press)
Heat Treat (Anneal)	Heat Treat (Anneal)	Heat Treat (Anneal)
Extrusion (Drawing)	Extrusion (Drawing)	Extrusion (Drawing)

Heat Treat (Anneal)	Heat Treat (Anneal)	Heat Treat (Anneal)
Shipping and Receiving (Straightening)	Extrusion (Drawing)	Extrusion (Drawing)
Shipping and Receiving (Cutting)	Heat Treat (Anneal)	Heat Treat (Anneal)
Heat Treat (Aging)	Heat Treat (Aging)	Shipping and Receiving (Straightening)
Shipping and Receiving (Packing)	Shipping and Receiving (Straightening)	Shipping and Receiving (Cutting)
	Shipping and Receiving (Cutting)	Heat Treat (Aging)
	Shipping and Receiving (Packing)	Shipping and Receiving (Packing)

Individual Warm-Up

1. List two or more reasons why is it important that the materials in production spend as little time in transit as possible between processing departments?
2. What is the aspect ratio of a room that is 21 feet by 7 feet?
3. The extrusion department must have an area of 40,000 ft² and a limiting aspect ratio of 4:1.
 - a. If your team chooses a footprint for this department of 320 feet by 125 feet, does this footprint meet the requirements of the extrusion department? If not, why not?
 - b. If your team chooses a footprint for this department of 500 feet by 80 feet, does this footprint meet the requirements of the extrusion department? If not, why not?
 - c. If your team chooses a footprint for this department of 360 feet by 90 feet, does this footprint meet the requirements of the extrusion department? If not, why not?

Data Collection Instruments

There were three types of data collected for this study. First, the team solutions for the MEA were collected electronically. The solutions were then graded by the researcher using a scoring rubric called the *Quality Assurance Guide* (Table 2). Second, for the teams analyzed in this study, an outside observer sat in on each team’s problem solving session and rated the team functioning using the *Researcher Observation Tool* (Table 3). Finally, immediately following the conclusion of the MEA, the students individually completed an online survey called the *Team Effectiveness Tool* (Table 4).

The goal of this study is to present the results of an investigation of the relationship between the quality of the solution produced by eleven student teams and their team effectiveness. The quality of the student team solution is rated using a rubric called the *Quality Assurance Guide* (Table 2) which assesses whether teams fully met the client’s needs. It is based on a five point scale where five corresponds to “Shareable and Reusable: The solution not only works for the immediate situation, but it also would be easy for others to modify and use it in similar situations” and one corresponds to “Requires Redirection: The product is on the wrong track. Working longer or harder won’t work.”

Student team effectiveness is assessed using two instruments. The observations of the teams were done using the *Researcher Observation Tool* (Table 3) which allowed the researcher to rate the teams on three forms of interdependency, two forms of potency, and two forms of goal-setting. The observer also had space in the tool to take detailed field notes of the performance of the team.

Through the *Team Assessment Tool* (Table 4), teams rated their own performance using 26 Likert-scale items which assess interdependency, potency, and goal-setting, as well as learning.

Table 2. Quality Assurance Guide.

<p>To prepare to assess quality of the solution (mathematical model), put yourself in the role of the client. To do this, it's necessary to be clear about answers to the following questions:</p> <ul style="list-style-type: none"> • Who is the client? • What solution (mathematical model) does the client need? • What does the client need to be able to do with the solution (mathematical model)? <p>Then, the quality of solution can be determined by focusing on the question:</p> <p style="text-align: center;"><i>How useful is the solution (mathematical model) for the purposes of the client?</i></p>		
Quality Score	Performance Level	How useful is the solution (mathematical model)?
1	Requires redirection	The product is on the wrong track. Working longer or harder won't work.
2	Requires major extensions or revisions	The product is a good start toward meeting the client's needs, but a lot more work is needed to respond to all of the issues.
3	Requires only minor editing	The product is nearly ready to be used. It still needs a few small modifications, additions or refinements.
4	Useful for this specific data given	No changes will be needed to meet the immediate needs of the client, but this is not generalizable to new but similar situations.
5	Sharable or reusable	The solution not only works for the immediate situation, but it also would be easy for others to modify and use it in similar situations.
<p>The students' product should make it clear that:</p> <ul style="list-style-type: none"> • The students went beyond producing a solution that <i>they</i> themselves can use to also produce a solution that <i>others</i> can use – by including needed explanations, and by making it as simple, clear and well-organized as possible. • The students went beyond thinking <i>with</i> the solution to also think <i>about</i> it – by identifying underlying assumptions (so that others know when the solution might need to be modified for use in similar situations) • The students went beyond <i>blind</i> thinking to also think <i>about</i> their thinking (by recognizing strength and weaknesses of their approach compared with other possible alternatives). 		

Table 3. Researcher Observation Tool.

<i>INTERDEPENDENCY – Cooperation among team members used to accomplish a task</i>	<i>1 = Strongly Disagree, 2 = Somewhat Disagree, 3 = Neutral, 4 = Somewhat Agree, 5 = Strongly Agree, DNO= Did Not Observe</i>					
This team used a process/method (i.e. code of cooperation) to hold each other accountable.	1	2	3	4	5	DNO
This team showed evidence of taking on roles and knowing the roles of other team members.	1	2	3	4	5	DNO
This team had an effective process to complete this MEA	1	2	3	4	5	DNO
What evidence did you observe of interdependency?	Notes:					
<i>POTENCY – Team potency is the shared perception that the team can reach their goals.</i>	<i>1 = Strongly Disagree, 2 = Somewhat Disagree, 3 = Neutral, 4 = Somewhat Agree, 5 = Strongly Agree, DNO= Did Not Observe</i>					
This team thought they could actually complete the MEA.	1	2	3	4	5	DNO
This team believed they could produce a good response	1	2	3	4	5	DNO

to this MEA.	
What evidence did you observe of potency?	Notes:
GOAL SETTING – Sets outcome goals and subgoals to accomplish tasks.	1 = Strongly Disagree, 2 = Somewhat Disagree, 3 = Neutral, 4 = Somewhat Agree, 5 = Strongly Agree, DNO= Did Not Observe
This team established interim goals to complete this MEA.	1 2 3 4 5 DNO
This team reflected on its goals during the process of solving this MEA.	1 2 3 4 5 DNO
What evidence did you observe of goal setting?	Notes:

Table 4. Team Assessment Instrument.

<p><i>Individual team members respond to this survey using Likert scale responses: 1 = Strongly Disagree, 2 = Disagree, 3 = Neutral, 4 = Agree, and 5 = Strongly Agree</i></p> <p>INTERDEPENDENCY</p> <ul style="list-style-type: none"> • My team collaborated effectively to complete our assignments. • My contributions were appreciated by each team member. • I was able to count on my team members to contribute their fair share of what was required. • Our team used a process/method (e.g., code of cooperation) to hold each member accountable. • At any particular time, I knew what each member of my team’s role was so I knew what to expect from him/her. • An outside observer would have concluded our team had an effective process to complete our assignments. • Team members arrived on time to team meetings. • Team members were prepared for team meetings. <p>LEARNING</p> <ul style="list-style-type: none"> • The solutions of my team were better than what I would have done on my own. • This team helped me understand the material presented in this course. • I acquired skills necessary to contribute to working on teams in the future. • Working on this team made me realize some things about myself (e.g., communication ability, leadership) that I was not aware of. • This team enhanced my academic learning. <p>POTENCY</p> <ul style="list-style-type: none"> • This team showed me that teamwork is an important component to individual success. • I would prefer to work on a team than on my own. • This team showed me that I have much to contribute to a team. • Working on this team gave me a sense of individual accomplishment. • This team showed me how teamwork contributes to problem-solving. <p>GOAL SETTING</p> <ul style="list-style-type: none"> • This team helped me accomplish my individual goals for this course. • This team showed me the importance of using clear, long term goals to complete tasks. • Our team reflected upon its goals in order to plan for future work. • My team made use of incremental goals (i.e., we set short-term goals) in order to complete course assignments on time. • My input was used to set our team goals. <p>VALIDITY</p> <ul style="list-style-type: none"> • Overall, I thought being on this team was a very negative experience. • Our team did not function well as a team; we did not establish any process to hold one another accountable nor did I ever know what individuals were responsible for.

Data Analysis

Data analysis employed quantitative and qualitative approaches. The triangulation of the quantitative and qualitative data allowed us to gain valuable insights into the relationship between the team functioning and the performance on the MEA.

Quantitative methods for analyzing data were applied to the data from the *Team Assessment Instrument*. This study was aimed at the eleven teams that were observed during the *Factory Layout MEA*; however, in order to analyze the 26 Likert-Scale items from the *Team Assessment Instrument*, an internal reliability test, Cronbach's coefficient alpha, was run using the results from all 1195 student responses from the course. Here Cronbach's coefficient alpha was 0.963. When the questions aimed at interdependency, potency, and goal setting were analyzed separately, they had alphas of 0.906, 0.918, and 0.857 respectively. All of the alphas exceed the necessary level of 0.80 which is considered very good for reliability. The instrument has been found to have validity in previous studies².

Qualitative methods were used to analyze the data from the student team solutions to the MEA. Using the *Quality Assurance Guide*, the qualitative data from the team solutions to the MEA were scored, therefore providing quantitative data. The solutions of the eleven teams were assessed by the team observer (who is also the researcher) and an outside researcher to ensure reliability. Here inter-rater reliability was 73%. When there were discrepancies, the observer and the outside researcher came to consensus on the team score for the MEA.

Results and Discussion

The results of the study indicate that there is correlation between the score of the MEA and aggregate score of a team's results from the *Team Effectiveness Tool* and the *Researcher Observation Tool*. Raw scores for each set of data can be seen in Table 5. The Observer Scores are sum scores of seven Likert-scale items that have the observer assessing three forms of interdependency, two forms of potency, and two forms of goal setting (Table 3). The Team Effect Scores are averaged sum scores from the *Team Effectiveness Tool* (Table 4). Finally, the MEA Quality Score is the assessed score from the *Quality Assurance Guide* (Table 2). In order to normalize the scores from each instrument, the scores were converted to rankings where *1* indicates that the score is the highest and *11* indicates the lowest score. Tied scores receive the same ranking and the next ranking is skipped. For example, if there are two scores that receive a *3* ranking, then the next place that is ranked is *5*. An aggregate team ranking was created to summarize the data in this study. The aggregate team score was determined by ranking the observer scores for all teams, ranking the Team Effectiveness scores from all teams, and then taking the average of the rankings. Because the aggregate team effectiveness score is based upon rankings, a lower score is better.

Table 5. Raw Data from All Instruments.

Team Number	Observer Scores	Team Effect Scores	MEA Quality Score
1	26	106	2
2	24	101	2
3	20	107	2
4	7	94	1
5	21	105	1
6	22	113	4
7	20	85	1
8	27	111	2
9	24	103	2
10	18	111	1
11	28	105	3

MEA Quality Score vs. Aggregate Team Score

The correlation between the MEA Quality Score and the Aggregate Team Score is the best correlation in this study (Figure 1). The Pearson product-moment correlation coefficient for this set of data is -0.792 and is statistically significant at a level of 0.01. According to Franzblau¹⁶, this level indicates a *marked degree of correlation*. The R-square value for this correlation is 0.627. The fact that the Aggregate Score correlations have a *marked degree of correlation* is very exciting, especially since this was the first MEA of the semester, the first time the students had ever responded to the *Team Effectiveness Tool*, and has a smaller sample size.

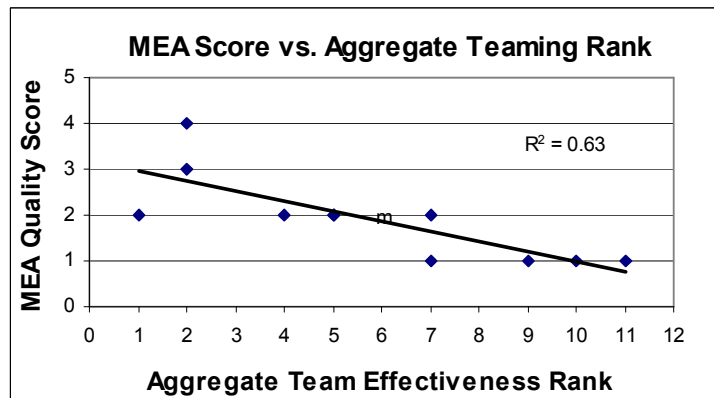


Figure 1. Linear Regression of MEA Score and Aggregate Teaming Ranking

MEA Quality Score vs. Observer Score

Correlation was assessed on the separate instrument scores as well. There is correlation between the MEA Quality Score, as based on the *Quality Assurance Guide*, and the sum scores from the *Researcher Observation Tool* (Figure 2). The Pearson product-moment correlation coefficient for this set of data is -0.555. This indicates a *moderate degree of correlation*¹⁶. This correlation was not found to be statistically significant at a level of 0.05. The R-square value is 0.308. Team 6 had the best MEA Quality Score of the observed teams; however, the ranking of this team was sixth. The observation notes from this team indicate that the team did not use the

time given for the problem well and, therefore, were rushing at the end to get the MEA finished. This accounted for low scores from the observer in the *effective process* portion of the *interdependency* section and in the *reflection on goals* in the *goal setting* section of the *Researcher Observation Tool*. However, the observer noticed that this team did a good job of holding one another accountable for their responsibilities. This discrepancy indicates that there needs to be more study done on the observation tool.

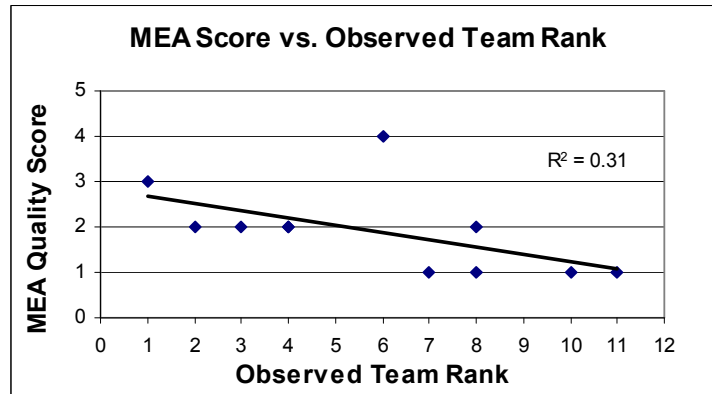


Figure 2. Linear Regression of MEA Score and Observation Score.

MEA Quality Score vs. Self-Reported Team Effectiveness Score

A final correlation was assessed between the MEA Quality Score and the sum scores from the *Team Effectiveness Tool* (Figure 3). The Pearson product-moment correlation coefficient for this set of data is -0.543, and was also not found to be statistically significant to a level of 0.05. The Pearson coefficient indicates a *moderate degree of correlation*¹⁶. The R-square value is 0.295. While this finding is positive, it is the weakest correlation of the study. This indicates that future work should be done to help students to do a better job of self-assessing their teams.

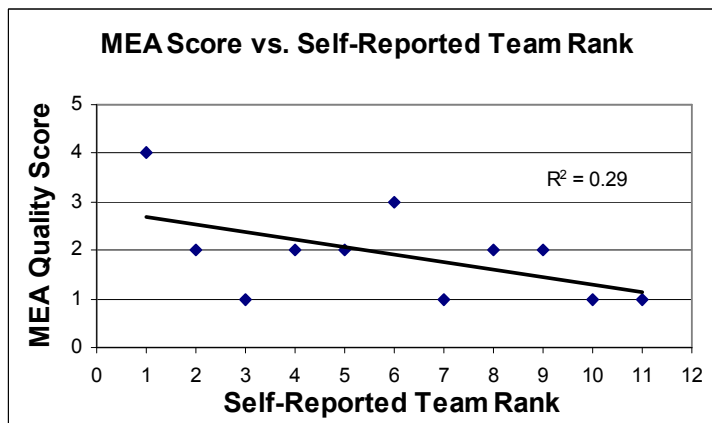


Figure 3. Linear Regression of MEA Score and Self-Reported Team Effectiveness Score.

The correlations between both the MEA Quality Scores / Observer Scores (Figure 2) and the MEA Quality Scores / Self-Reported Scores (Figure 3) are significantly smaller than the

correlation from the Aggregate Score (Figure 1). This seems to indicate that using both results together to form an aggregate score better represents the team effectiveness than either of the scoring tools alone. However, because the linear regression and correlation is similar in both individual scores, this demonstrates validity in both instruments.

Conclusions and Future Directions

The findings from the correlations between the MEA Quality Score and each of the team effectiveness scales are promising. The findings presented here suggest that, during the Model-Eliciting Activity, effectiveness in student teams can boost the quality of team solutions. This result shows potential for the ongoing challenge to meet ABET criteria.

This study begins to answer the fundamental question of whether or not team dynamics affect quality of responses on Model-Eliciting Activities. The analysis of the team effectiveness for the *Factory Layout* MEA and the quality of solutions by student teams raises new questions. *Do the correlations between MEA Quality Scores and team effectiveness increase as the students have done more Model-Eliciting Activities? What is the correlation between the Team Effectiveness Tool and the quality of student solutions when looking at all teams in the first-year engineering course? How do these correlations differ from the smaller set of observed teams?* Using the results from this study and from further research in this area, researchers can begin to look at which kinds of team characteristics are more likely to produce better solutions to MEAs and how to teach students to embody those characteristics as team members. These findings could have great impact on how we teach problem solving and teaming to our students.

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