

TEAM PROGRESS CHECKSHEET: A STUDY CONTINUATION

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Abstract

In an effort to compete on a global level, companies have used teams to tackle complex designs and to continually improve in areas such as quality and service. Large amounts of money are spent on training teams but few organizations evaluate the teams once they return to the job. One way to assess the teams after training is to evaluate whether the behaviors taught for teaming have been incorporated. Survey instruments are an acceptable method to accomplish this. Work has continued on one such survey called the Team Success Questionnaire (TSQ) as to its psychometric properties. The instrument contains eleven questions pertaining to teaming attributes. The TSQ has solid reliability with a Cronbach's alpha value of 0.94. It also has construct, concurrent, and discriminate validity. The TSQ correlates with both team performance and group development. The results of this research show that the TSQ would be an appropriate method to assess team success.

Introduction

Doing business in the past was a much easier task than it is today. Competition was usually local or at least within national boundaries. In today's business climate the competition is fierce and encompasses the world, thanks to advanced technology and the Internet. Products no longer are simple in their design and manufacture, nor can a single person do it all. Products have become complex and require breadth of knowledge among many people. One method for tackling these complex projects is to put together a team of people to address these multifaceted products in an effort to compete and to continuously improve in areas such as service and quality.

The magazine *Training* performs an annual industry report on employer-provided training in their October issue. Each year they assess U.S. companies who have greater than 100 employees. The 1992 report showed that over all sized companies, 82% had employees who were members of a team, with 45% being on a permanent one (Gordon, 1992). Only 35% had self-managed work teams whose primary functions were to set work schedules, deal directly with external customers, set production quotas or performance targets, and to train. The least common function was firing. In the *Training* 1996 report, 73% of all sized organizations used teams with 31% having self directed ones. The 2003 report did not contain this specific

information, however, teams continue to play a major role in today's productivity (Galvin, 2003).

With organizations utilizing teams, research into teamwork that attempts to understand the process and performance outcomes is widespread. The following paper describes a tool, the Team Success Questionnaire (TSQ), which is under development to measure team success in the areas of group development as well as performance. This instrument was formerly known as the Team Progress Checksheet (TPC) developed by Utley with the following a continuation of that research (Fortune, 2003). Prior work on this instrument was presented at the American Society of Engineering Management (ASEM) conference in 2003.

Literature Review

Why is there a need for survey instruments such as the TSQ? Eighty-two percent of companies stated that they offered team building training (Galvin, 2003). This type of employer-sponsored training is not a cheap endeavor. The same industry reports previously mentioned that in 1996, \$59.8 billion was spent on training while in 2003 it was \$51.3 billion. Team-building ranked 6th in 1996 behind new employee orientation, leadership, computer skills, performance appraisals, and safety with 67% of companies offering this specific type of training. Additionally, according to the 1996 report, companies are under pressure to justify how their budgets are being spent and what impact the training has had on the bottom line. Kirkpatrick (1996) created a four-level model over 45 years ago that is still used today. The model is a way to evaluate the training offered by organizations utilizing level 1 (reaction) which is measuring the reaction of trainees to the aspects of the training such as topic and speaker. Level 2 is called learning, which is measuring the knowledge, skills, or changed attitudes due to the training. Behavior, or level 3, measures the extent to which trainees change their on-the-job behavior in light of the training offered. Kirkpatrick (1996) refers to this level as transfer of training. Level 4 is titled "results," although some have termed this "return on investment" (Tyler, 2002). This measures the bottom line impact gained from training, such as increased sales, improved quality, or reduced costs. Kirkpatrick believes that the model is widely used because it is practical and simple. In 1996, according to *Training* magazine, organizations used these four levels of training evaluation methods as follows: level 1 (86% on 83% of the courses), level 2

(71% on 51% of the courses), level 3 (65% on 50% of the courses), and level 4 (49% on 44% of the courses). In 2002, the percentage of companies that used these four levels of evaluation decreased. Seventy-eight percent used level 1, 32% used level 2, 9% used level 3, and 7% used level 4 (Tyler, 2002). Justifying budgets is not a trend that is going away. If anything, it is becoming increasingly scrutinized in this era of large companies such as Enron and WorldCom failures, as well as the budget cutting that is going on in companies and educational institutions of all sizes. A reliable and valid survey instrument, such as the Team Success Questionnaire could offer assistance in evaluating the team building training once the employee returns to their job (level 3). It would offer a quick and inexpensive method to ascertain whether the team is succeeding, in both group development and performance, or if there are issues that need to be addressed. The TSQ is also generic enough that can be used by a wide variety of organizations. A good survey is brief, clear, objective, and focused. The TSQ meets these criteria. Tyler (2002, p.93) offers advice for the training unit. "Make an effort to plan level three and four evaluations, whether upper management is asking for that kind of data or not. Sooner or later someone will come back and ask you to justify whether the training organization should exist or not. If you can prove your training is effective [and crucial to the bottom line], it puts *you in a very good position.*"

There is a large volume of work on instruments that can be used to evaluate teams, as described, that spans many research fields such as nursing, education, psychology, and small groups. There are surveys available that are used to measure group development, performance, or a mix of both. Before going any further, the terms teamwork, group development, performance, and team success need to be defined. Teamwork deals with the inner workings of the team. Examples of inner working characteristics are communication, managing conflict, consensus decision, mutual accountability, respect, shared responsibility, joint work product, understanding the purpose of the team, caring about the other members, diversity, listening, contributing, a shared overarching goal, time management, and a shared mental model. Group development, or team progress, is defined as "a naturally occurring process that involves three or more individuals interacting together for a period of time. How the group develops and how long it takes for the group to meet its goals are directly related to the interaction and involvement of the leader and the group members." (Kormanski, 1999, p. 6) Teamwork fits into group development in that as the group interacts and develops, the defined characteristics of teamwork become a part of how the group functions. For example, Katzenbach and Smith (2003) describe that

mutual accountability is not a part of the team until they have progressed over time to the stage of a real team. The better the team develops, the more characteristics they gather and master and, according to theory, the better they will perform. Team performance is used to describe the outcome products from the team. Things such as a white paper, an enhanced process, a plan for improved customer service, or a lower number of defects are examples of performance. Team success is a combination of both group development and team performance that together enables a team achieve its mission. With these definitions in mind, the number of survey instruments that measure group development and/or performance that are psychometrically sound, that is have reliability and validity, is small. The following are examples of validated instruments that could potentially be used for level 3 evaluations of team training. Three categories of these instruments are presented: Group Development, Performance, and Group Development/Performance.

Group Development. In the area of group development there are several surveys available. The Group Environment Scale measures relationships, personal growth and system maintenance/ change within a group. The original contained 90 questions but has been adapted down to 27 (Moos & Humphrey 1974; adapted by Schmitt, Heinemann & Farrell 1992). The Work Group Functioning Model contains 14 questions that deal with group homogeneity, clarity of work group goals, group cohesiveness, open group process, and internal fragmentation (Lawler, Cammann, Nadler & Jenkins, 1975). Wheelan and Hochberger, 1996, describe a 60-question survey called the Group Development Questionnaire, which measures group development. The Group Process Questionnaire (GPQ), developed by Miller in 1997 for her dissertation, is a 31-question survey that measures group development based on the theories of Tuckman and Gersick. The Tuckman model suggests four stages of group development: forming, storming, norming, and performing (Tuckman, 1965). The stage of adjourning was added at a later date (Tuckman and Jensen, 1977). Gersick describes a model called punctuated equilibrium in which group development varies widely and there is no set sequence of stages (Gersick, 1991). The Team Development Rating Scale is used as a means to track team development through five stages: awareness, conflict, cooperation, productivity, and separation (Kormanski and Mozentzer, 1987). The instrument contains 10 questions. The Team Climate Inventory (TCI) contains 38 questions to assess five components of team performance: vision, frequency of interaction, participative safety, task

orientation, and support for innovation (Anderson & West, 1994).

Performance. Measuring performance is a difficult task because teams can have different criteria for what is considered performance. Engineers might say performance is based on the project being on time or early and at or below budget, while an emergency room team might say it is based on the number of lives saved. “A vexing and important problem is the lack of a common conceptual and operational definition of the term performance” (Kline and McGrath, 1998, p. 20). Because of this quandary, survey instruments that measure performance are more difficult to find. The Business Engineering Technology Performance Tool contains a 5-question instrument that is simple, generic, and quick (Halfhill, in press).

Group Development/Performance. The Team Assessment Instrument contains 70 questions that deal with team cohesion and performance (Allen, 1994).

Of the described instruments, only one evaluated both group development and performance. These two criteria are the foundation of the development of the TSQ.

A Need Exists for Additional Surveys. All of the aforementioned surveys are acceptable for measuring teams. The drawbacks in their use are that either they are too long and/or desire more psychometrically sound attributes. These issues have led to research into creating an instrument that is both short and has established psychometric properties.

Development of the TSQ

The TSQ was born from a research collaboration. The Industrial and Systems Engineering (ISE) department and the Mechanical Engineering (MAE) department at UAH began collaborations in the year 2000. The MAE senior design class pitted teams against one another in an effort to design the best solution to a set of requirements set forth by a customer. The ISE department began observing the teams as they worked and have continued to do so for the last five years. In the year 2004, the customer was the U.S. Army Aviation and Missile Research Development and Engineering Center located in Huntsville, Alabama. The project was to design a smart bullet to defend military personnel from rocket, artillery, and mortar attacks. This one semester class offered a complete study ground for teams because the entire team process from forming to adjourning could be seen.

The Team Progress Checksheet, later renamed the TSQ, was created as a survey tool to be utilized in the observations of the teams. The 11-question survey was developed to capture information concerning the

development of the team, as well as how the team was performing. Topics such as role establishment, participation, overall satisfaction, and learning (as an individual and as a team) were part of the instrument. Each question had a sliding scale of 1 to 10 with 1 meaning needs work while 10 meant excellent. Since the TSQ was developed, interest has been generated in determining its reliability and validity. Additionally, there was curiosity as to whether the survey could be utilized by organizations to assess their teaming efforts as previously described.

Pilot Research

Pilot work into the reliability and validity of the TSQ is complete. Two versions have been piloted. Version 1 uses a 10 Point Likert scale (1 being “needs work” and 10 being “excellent”) and contains eleven items concerning team development and performance. It has been used both in paper and electronic form. The second version reverse scores item 4 (wasted time) and uses strongly disagree to strongly agree anchors for the 10 point Likert scale (1 strongly disagree, 10 strongly agree). Item 4 was reverse scored to deter respondents from answering the same value for every question. Item 11 was split into two questions dealing with satisfaction in teaming and with the progress and attainment of goals to create a twelve-item instrument. Version 2 has been exclusively administered electronically. The second version is still under investigation but preliminary data are presented.

Norming Population. Both versions of the questionnaire have been given only to engineering students and practicing engineers in the workplace.

Reliability. Reliability is the proportion of total variance attributed to true variance (Cohen, 2002). There are multiple sources of error variance. Among them are test construction, test administration, test scoring and interpretation, as well as misunderstanding the question. Cronbach’s α is a measure of reliability, which is a model of internal consistency using all possible split half correlations. The Chronbach α was calculated using SPSS Version 11.5. The TSQ was given over time to several teams. Therefore, the reliability was calculated based on the first time the instrument was seen by a team. The results are presented in Exhibit 1. The reliability for both versions is very high.

Exhibit 1. TSQ Reliability Results

	Version 1	Version 2
Number of Variables	11	12 (reverse scored question 4)
# of teams	23	4
N of Cases	139	32
Alpha	0.94	0.92

Factor Analysis. Factor analysis is a method “to describe the covariance relationship among many variables in terms of a few underlying, but unobservable, random quantities called factors” (Johnson & Wichern, 2002, p. 477). According to Cohen and Swerdlik (2002) it is a data reduction method with the purpose being to identify factor(s) in common between test scores on subscales within a particular test. Factor analysis makes use of Eigen values to explain the amount of variance contributed by the various identified factors. Interpretation of factor analysis is difficult because it is hard to decide what factors should be retained. One method is to retain factors that have an Eigen value of one or higher. Another is by using a scree plot. A scree plot graphs the Eigen magnitude verses their ranking. In order to determine the appropriate number of factors to keep, a bend or elbow in the plot is identified (Johnson and Wichern, 2002). Based on the Eigen value method, using a non-rotated analysis, version 1 retains a single factor and version 2 retains 3. This is also supported in the scree plots presented in Exhibits 2 and 3. The single factor in version 1 that is retained explains 65.4% of the variance with the communalities of the eleven questions having values of 0.55 or better. The three factors retained with version 2 of the TSQ cumulatively explain 71.3% with communalities being 0.57 or better. Using a rotation method such as Varimax did not simplify the factor loadings for version 2 because rotation does not help when a large single factor dominates. It should be noted here that version 1 and 2 had the same initial 10 questions except that version 2 had question 4 reversed. Questions 11 and 12 were different between the two versions. Because of this, several combinations of the questions for version 2 were tried. The results were that the questionnaire format with the 12 questions and the reversing scoring of 4 offered the highest reliability and the most variance explained by the three identified factors. Therefore its reliability and validity is presented.

Exhibit 2. Version 1 of the TSQ Scree Plot

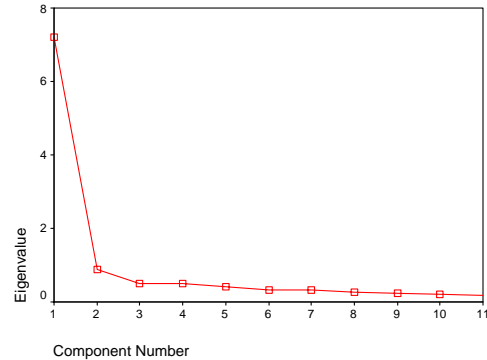
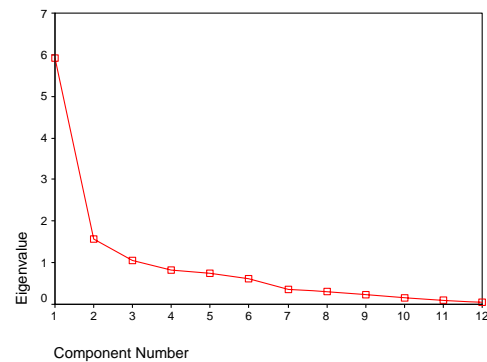


Exhibit 3. Version 2 of the TSQ Scree Plot



Factor loadings can show how well each question correlates with the identified factors. A factor loading can be considered significant if it is greater than 0.3 or 0.4 (Cohen 2002). The correlation results for both versions of the TSQ, based on the identified number of factors to retain, as calculated by SPSS, are presented in Exhibits 4 and 5. Notice that version 1 of the TSQ has significant correlations for all questions on a single factor. Version 2 has questions that correlate with more than one factor.

Exhibit 4. TSQ, Version 1, Factor Loading

Question	Factor I
1	0.78
2	0.82
3	0.74
4	0.81
5	0.76
6	0.78
7	0.81
8	0.79
9	0.85
10	0.83
11	0.90

Exhibit 5. TSQ, Version 2, Factor Loading

Question	Factor 1	Factor 2	Factor 3
1	0.65	0.89	< 0.3
2	0.72	< 0.3	< 0.3
3	0.50	< 0.3	< 0.3
Reverse	< 0.3	< 0.3	0.75
4			
5	0.78	< 0.3	< 0.3
6	< 0.3	0.71	< 0.3
7	0.67	< 0.3	0.40
8	0.84	< 0.3	< 0.3
9	0.85	< 0.3	< 0.3
10	0.80	< 0.3	< 0.3
11	0.93	< 0.3	< 0.3
12	0.81	< 0.3	< 0.3

Validity. Validity is an important component of test instrument development because without it, the tool is not psychometrically sound. There are several types of validity with the applicable ones being described.

“Construct validity is a judgment about the appropriateness of inferences drawn from test scores regarding standings on a variable called a construct” (Cohen and Swerdlik, 2002, p. 644). The factor analysis results show that for version 1 of the TSQ, there is one construct or factor. Version 2, on the other hand, appears to have 3 constructs or factors. The question is, what are the constructs? The TSQ was designed to measure team success, which, according to the definition given previously, is a combination of group development and performance, and therefore this is where the construct validity work began. The Business Engineering Technology Performance Tool, described previously, was identified as an instrument to use for construct validity. This rating form additionally contained 14 questions that were described as viability that could be used as a separate survey instrument. The

viability questions referenced many of the characteristics previously defined for teamwork. Therefore, it appeared to be an instrument that could be used to check the construct of group development. These two instruments were used with permission from the author. Version 1 of the TSQ has been given to 19 teams that also completed the two identified surveys. All three surveys were filled out at the same time. Version 2 has not been piloted for construct validity. The results show that the TSQ correlates with both performance and group development (viability) whether the engineering teams were at the college level or practicing engineers in the workplace. The results are shown in Exhibit 6.

Note: The reliability of the Business Engineering Technology Performance Tool (5 questions) was 0.88 while the group development (viability) instrument was 0.79.

Exhibit 6. Construct Validity

	TSQ	Performance	Group Development
TSQ	---		
Performance	0.70	---	
Group Development	0.65	0.83	---

Because the instrument correlated with both group development and performance, the original name of Team Progress Checklist did not capture the nature of the instrument. It was felt that both group development and performance are components of a team being successful, thus the name was changed to the Team Success Questionnaire.

“Concurrent validity is a form of criterion-related validity that measures how well one test score is related to some criterion measurement obtained at the same time” (Cohen and Swerdlik, 2002, p. 643). Each team had a manager, a course instructor, and/or independent review boards to assess how well the team worked together and/or performed. The 5 teams that were practicing engineers were scored by managers who completed both parts of the Business Engineering Technology Performance Tool based on their perceptions of how the teams were doing on those aspects. Fourteen teams were given a score between 1 (low) and 5 (high) by the course instructor based on teamwork and performance. An independent review board scored the 6 mechanical engineering teams based on their technical output and management of the project. These scores were also from a low of 1 to a high of 5. Management and review board ratings were given within one week of the participants completing the TSQ. Exhibit 7 shows the concurrent validity

information, based on correlations to the version 1 of the TSQ, for each of the different methods. Results suggest that the TSQ has acceptable levels of concurrent validity.

Exhibit 7. Concurrent Validity

	N	Management Perspective		Instructor	Review Board
		Performance	Group Development	Performance	Performance
Industry Teams	5	0.78	0.79		
College Teams	14			0.47	0.67

Another consideration that should be taken into account when developing a survey instrument is the concern of a self-report questionnaire. The assumption is that people answer in an honest and truthful manner. One way to test this assumption is by using a method to assess if the survey taker is answering candidly or in a socially desirable way. The Marlowe-Crowne Social Desirability Scale (MCSDS) was developed as a means to determine whether a person was answering questions in a “faking good” or “faking bad” way which can distort test scores (Crowne and Marlowe, 1960). Since its inception, the instrument has been hotly debated as to its validity but is still considered an industry standard. Multiple researchers have developed shorter versions of the original 33-question instrument (Fischer and Fick, 1993, Loo and Thorpe, 2000, Reynolds, 1982, Strahan and Gerbasi, 1972). This instrument, given in conjunction with a survey instrument under development, can offer a method to show discriminate validity. In other words, the TSQ should not correlate with something it is not expected to be measuring. The added bonus is that it can show truthfulness in the respondent.

The shorter version of the MCSDS developed by Strahan and Gerbasi and later modified by Fischer and Fick to contain only six questions was given to participants at the same time as version 2 of the TSQ. Thirty-two responses were garnered. The correlation between the two instruments was 0.175, which indicates very good discriminate validity.

These preliminary results shows that the TSQ appears to be a valid and reliable instrument that could be used as a quick and inexpensive method to check team success once trained employees are back to their job and utilizing the team building skills obtained.

Discussion

Based on the pilot work, it appears that version 1 of the TSQ is a better version to carry forward. It has good

reliability, loads on a single construct, and correlates with both performance and group development as anticipated. Version 2 would require additional work to better understand the factor analysis and to determine the construct validity. The only information not gained from version 1 was the correlation to the MCSDS, which is information that is needed for discriminate validity.

A valid question at this point is if version 1 is the selected one for further study, how does it load on a single factor yet correlate with two different constructs? It is possible for both performance and group development to contribute to the single construct. The contributions of the two constructs may be 50/50 or one might contribute more. One possible way to address this is to look at the sequential sum of squares to identify what one contributes to the model when the other is already contained. This is an area to be further explored.

Future Plans

The future plans are to take version 1 of the TSQ and perform a large-scale study to determine its reliability and validity. In order to do this, a large number of participants need to consent to participate. Additionally, a different survey instrument was desired to measure group development than the viability survey that was used as a surrogate. After reviewing several acceptable candidates, the Team Development Rating Scale, previously described, appears to fit best. Permission has been granted for its use by the author.

There is a current study of teams being performed at UAH. The study leader has agreed to allow the TSQ research to use a subset of currently participating teams. A minimum of 80 participants is desired. The study leader has placed a questionnaire on the web that participants complete. An option to participate in the TSQ research is given once the initial questionnaire is submitted. This will take the person to another webpage that contains demographic questions, the TSQ, the 5 performance questions from the Business Engineering Technology Performance Tool, the Team Development Rating Scale, and the 6-question short form of the MCSDS (all previously described). The combined number of survey questions is 32 and takes a person less than 10 minutes to complete. From the data collected, the reliability of the TSQ will be calculated as well as the various forms of validity: construct, concurrent, and discriminate. The desired outcome is a psychometrically sound survey instrument that can be used to measure teams after attending team training or as a means to ascertain how teams are progressing and performing.

Conclusions

A survey instrument, the TSQ, has been piloted as a tool for assessing whether the attributes of teaming that

are taught in training are being incorporated. The tool is short, has good reliability, and has been demonstrated to be valid using several methods. It correlates with both team viability and performance. Further work is planned on a larger sample size to fully elicit the psychometric properties.

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