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CONSEQUENCES OF TEAM CHARTER QUALITY: TEAMWORK MENTAL MODEL SIMILARITY AND TEAM VIABILITY IN ENGINEERING DESIGN STUDENT TEAMS

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ABSTRACT

Since 1996 ABET has mandated that undergraduate engineering degree granting institutions focus on learning outcomes such as professional skills (i.e. solving unstructured problems and working in teams). As a result, engineering curricula were restructured to include team based learning—including team charters. Team charters were diffused into engineering education as one of many instructional activities to meet the ABET accreditation mandates. However, the implementation and execution of team charters into engineering team based classes has been inconsistent and accepted without empirical evidence of the consequences.

The purpose of the current study was to investigate team effectiveness, operationalized as team viability, as an outcome of team charter implementation in an undergraduate engineering team based design course. Two research questions were the focus of the study: a) What is the relationship between team charter *quality* and *viability* in engineering student teams, and b) What is the relationship among team charter *quality*, teamwork mental model *similarity*, and *viability* in engineering student teams?

Thirty-eight intact teams, 23 treatment and 15 comparison, participated in the investigation. Treatment teams attended a team charter lecture, and completed a team charter homework assignment. Each team charter was assessed and assigned a quality score. Comparison teams did not join the lecture, and were not asked to create a team charter. All teams completed each data collection phase: a) similarity rating pretest; b) similarity posttest; and c) team viability survey.

Findings indicate that team viability was higher in teams that attended the lecture and completed the charter assignment. Teams with higher quality team charter scores reported higher levels of team viability than teams with lower quality charter scores. Lastly, no evidence was found to support teamwork mental model *similarity* as a partial mediator of the team charter *quality* on team *viability* relationship.

Foci for future research opportunities include using: a) online data collection methods to improve participant adherence to similarity rating instructions; b) story or narratives during pre- and posttest similarity rating data collection to create common levels of contextual perception; and c) support to ensure charters are integrated into the full project life cycle, not just a pre-project one time isolated activity.

Twenty five sections, on average, of EDSGN 100 are taught each spring and fall semester. Consistent instructor expectations are set for the technical aspects of the course. However, ideas to foster team effectiveness are often left to the discretion of the individual instructor. Implementing empirically tested team effectiveness instructional activities would bring consistency to EDGSN 100 curriculum. Other instructional activities that would be of benefit to engineering educators include qualitative inquiry—asking intrateam process questions (at the mid-point of the project) and in-class reflection—dedicated time, post project, to discuss what went well/not well within the team.

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Jeremiah 29:11 states: “For I know the plans I have for you,” declares the Lord, “plans to prosper you and not to harm you, plans to give you hope and a future.”

With a child’s hand in each of mine, and hope in my heart I trusted the Lord and began my doctoral journey. Armond Isaiah and Channing Grey, the Hughston Duo, you are my joy, my peace, my gift to the world. Thank you for being the dynamic duo. Thank you for being obedient, patient, and all-around awesome children! You have sacrificed so much so that I could accomplish a personal lifetime goal. It has not been easy, but I hope it has been worth it.

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Chapter 1

Introduction

Students are integral to the success of future work teams in private industry, government, and education. The complex nature of work awaiting engineering graduates cannot be accomplished by individuals alone. A commonly held view, as stated by The Foundation Coalition (2001), is that sole contributors are less effective and least productive in the multidisciplinary team-centered work environment. The American Society for Engineering Education (ASEE) was one of the first organizations to recognize and attend to the growing gap between student skill set and teamwork labor market demands (American Society for Engineering Education, 1994). ASEE advised engineering program administrators to reshape curricula to incorporate and accelerate "team skills" in the classroom. To address this concern the Accreditation Board of Engineering and Technology (ABET) issued a mandate: engineering programs must demonstrate that their graduates have the "ability to function on multi-disciplinary teams" (Lattuca, Terenzini, & Volkwein, 2006, p. 19). Classroom experiences in higher education must adequately prepare today's teams for tomorrow's challenges.

> Teams, as defined by Kozlowski and Ilgen (2006), consist of:
>
> (a) two or more individuals who (b) socially interact (face-to-face or increasingly, virtually); (c) possess one or more common goals; (d) are brought together to perform organizationally relevant tasks; (e) exhibit interdependencies with respect to workflow, goals, and outcomes; (f)

> different roles and responsibilities; and (g) are together embedded in an encompassing organizational system, with boundaries and linkages to the broader system context and task environment (p. 79).

Teams have become commonplace in engineering education. As an example, Lattuca et al. (2006) reported that over three-fourths of engineering program chairs (study total; *n* = 147) and more than one-half of the faculty members (study total; *n* = 1,243) survey responses in *Engineering Change: A Study of the Impact of EC2000* (EC 2000) indicated a moderate to significant increase in the use of teamwork, group work, and design projects from 1994 to 2004. EC 2000 was the first national study of the effectiveness of the 1994 accreditation requirements from ABET (Lattuca et al., 2006). Although team usage at the undergraduate level had dramatically increased, employers reported observing merely modest improvement in new graduates' team skills. Lattuca et al. (2006) indicated a majority of employers (*n* = 1,622) rated new hires as having only adequate team skills (p. 1).

Students are often placed in teams whose assignments comprise meticulously designed and documented technical components of the assigned task. However, these members are regularly left on their own to figure out how to function as a team (Yang & Jin, 2008). In a study of team effectiveness in relation to virtual versus co-located teams, Yang and Jin (2008) tested how the lack of teamwork guidance could negatively affect a team's effectiveness. The authors reported that co-located teams relied more on social orientation (e.g., getting work done through relationships) as opposed to task-oriented (e.g., focused on the work and how to get the work done) processes (p. 1). Teams rated

themselves on ten team effectiveness characteristics that addressed both social- and task-related dimensions. Virtual teams in the study received teamwork instruction; the co-located teams did not. This disparity in teamwork instruction was cited as a key potential reason co-located team members self-rated lower on two of the ten team effectiveness characteristics—"experimentation" and "evaluation". The aforementioned characteristics reflect levels of teamwork. Yang and Jin supposed the co-located teams' lack of teamwork skills was detrimental to the teams' effectiveness.

Although four years apart, the findings from Yang and Jin could lend credence to the EC 2000 report that employers only saw minimally adequate team skills from engineering graduates. Additionally, this finding resonated with faculty members tasked with launching a freshman Science, Technology, Engineering, and Math retention program at a small public university. Faculty members were concerned that students typically know the "what" of team problem-solving but lack the "how" to be effective in a team (K. Shumaker, personal communication, July 2012).

Teaching engineering students how to be effective on teams presents a big challenge for educators. The amount of time required for proper team skills instruction (Marin-Garcia & Lloret, 2008) and lack of consistent content in team lessons and professional development preparation of faculty and instructors (Adams & Pereira, 2002) are cited as areas of concern. According to (Marin-Garcia & Lloret, 2008, p. 2), team "sensitizing activities" could take up to five hours of total course time. Five hours equates to about two weeks of instruction time. Additionally, according to Li, Swaminathan, and Tang, (2009) students that are attracted to the engineering discipline are typically not interested in teamwork.

In their pilot study, "Measuring Faculty Preparation to Lead Teams in the Engineering Classroom", inconsistent levels of implementation, attitudes toward team use, and ability to effectively lead teams were reported by Adams and Pereira (2002). Fewer than 42% of participants provided instruction on team process skills; the range of consistency spanned from 32% to 42% (Adams & Pereira, 2002, p. 2). Educators, particularly in technically intense disciplines such as engineering, must determine how much time within the course and where in the schedule of topics to dedicate time to team process skills. Additionally, much like engineering managers, engineering educators' professional development time is primarily driven by the need to stay proficient in their specific engineering discipline (i.e., focusing on the "what", but neglecting the "how"—Farr & Brazil, 2010). The severity of these challenges can be lessened by engineering educators applying existing research from disciplines outside of engineering.

Synthesizing existing research from disciplines such as Industrial/Organizational Psychology (I/O P) and Business Administration can help engineering educators to overcome team effectiveness issues in the classroom. Researchers in I/OP, the scientific study of the workplace (Society for Industrial & Organizational Pyschology, Inc., 2013) have made great advances in providing theoretical and empirical understanding of teamwork effectiveness and performance antecedents. One such example is team cognition, defined as "how processes at the intraindividual (occurring within the individual) level are dependent on and interact with processes at the interindividual (taking place between individuals) level" (Fiore & Schooler, 2004, pp. 137–138).

According to DeChurch and Mesmer-Magnus (2010a), the team cognition literature from I/OP has burgeoned with growing research in the realm of team mental

models—organized mental models of relevant team-related information; transactive memory systems—cooperative division of team-relevant knowledge among members (Lewis, 2003); and cognitive consensus—"similarity among group members regarding how key issues are defined and conceptualized" (Mohammed, 2001, p. 1). These cognitive frameworks have been well established in the team literature as methods to use in measuring and predicting team performance and a host of team output antecedents. A formal definition of team mental models is "organized mental representations of the key elements within a team's relevant environment that are shared across team members" (Mohammed, Ferzandi, & Hamilton, 2010, p. 877), including: objectives, "team roles, behavioral expectations, and interaction patterns" (Kraiger & Wenzel, 1997, p. 65). The sharing of these key areas is a precursor to team effectiveness and performance (Cannon-Bowers, Salas, & Converse, 1993) and is a mechanism in explaining effects on input variables on team outcomes (DeChurch & Mesmer-Magnus, 2010a, p. 2). Team outcomes traditionally consist of internally (team viability) and externally (performance) driven criteria (Kozlowski & Bell, 2012, p. 430).

Researchers in Business Administration have used team charters to positively impact student team outcomes. Team charters have been shown to improve team effectiveness and performance in business management education (Mathieu & Rapp, 2009). Byproducts of team charter implementation include common assumptions and mental model-sharing (Marcellino, 2008). In a study of 24 MBA student teams, Marcellino (2008) found that team contracts were being used as an "instructional tool" to start team learning and create shared vision. Also studying MBA students, Byrd and Luthy (2010) referred to team charters as cognitive maps set by each team to guide them

through processes to achieve their goals. Anecdotal data suggest that once students acquire team chartering skills, they will be poised for success in future similar team interactions (Hunsaker, Pavett, & Hunsaker, 2011) and hence improve the likelihood of team effectiveness.

There is minimal literature on team charter use in engineering team-based design courses. Kellar et al. (2000); Moore, Diefes-Dux, and Imbrie (2006); and Pazos, Ustun, and DelAguila (2011) all referred to having freshmen engineering students sign a form of team charter as a part of the team formation process. No details were given in the articles on the content and use of these charters. Extant engineering education literature is deficient of empirical support for the use of team charters and does not indicate whether they are beneficial or detrimental to engineering student teams. We do not know how team charters in engineering design-based courses impact teams' effectiveness.

Team viability, defined as members' willingness to work as a team in the future, has been consistently linked as a criterion in measuring team effectiveness and performance (Tekleab, Quigley, & Tesluk, 2009). In their conceptual study on team viability, Bell and Marentette (2011) concluded that team viability is important to performance when three boundary conditions are met—when members: (a) engage in multiple performance cycles; (b) are likely to undergo and respond to team member changes; and (c) work as a team over the long term. Freshmen engineering design team-based classes typically fulfill the three boundary conditions, particularly when the teams are kept intact for more than one project or have multiple graded milestones within a project cycle. Also, students tend to drop and/or add the class for any number of reasons;

this is likely to happen after teams have been assigned and the project work has started. Lastly, design teams are usually grouped together for the duration of the semester.

The Problem

Industry and accreditation institutions have demanded that graduating engineers be able to effectively contribute in a team environment (American Society for Engineering Education, 1994; Newell, 1990). To maintain accreditation and relevance, colleges and universities revamped existing curricula and developed new courses to include student team activities (Lattuca et al., 2006). However, the ways in which teams have been planned, implemented, and evaluated within engineering education have not been consistent (Adams, 2003). Engineering educators have attempted to answer the call to produce team-savvy engineering graduates by assigning team-based projects and subsequently implementing teamwork-building activities such as team charters. The problem is the inconsistencies in team charter use, measurement, and understanding of effect in engineering design team-based classes. Educators and students should have an indication of how and what team charter creation does for engineering design team-based classes.

Purpose of the Study

The purpose of the study was to test team charter creation as an instructional antecedent of team viability by comparing teams creating team charters with teams not

creating team charters in engineering design team-based classes. Specifically, the study analyzed the relationship between team charter quality and team viability by giving one group team charter instruction and having them create a team charter, while the other group did not receive team charter instruction and were not asked to create a team charter. Second, teamwork mental model similarity was examined as a partial mediator of team charter quality on team viability relationship. Prior team experience and prior experience creating a team charter were treated as extraneous variables.

The study was administered in the College of Engineering at The Pennsylvania State University, a large mid-Atlantic public land-grant university. Participants were enrolled in Engineering Design 100—an entry-level freshman course. The unit of measurement for the study was at the team level; teams were composed of four students. The study was conducted within the actual course settings during regular class time.

Significance of the Study

Contributions to extant literature were made by extending the work of Mathieu and Rapp (2009), and McDowell, Herdman, and Aaron (2011).

Mathieu and Rapp (2009) examined the interactions among team charter quality, team performance strategies, and performance trajectories. Team performance was operationalized as a numeric composite of five objective factors (e.g., after-tax profits, bond rating, etc.) directly related to the business simulation in the study. The authors found that teams with high-quality team charters and high-quality performance strategies demonstrated higher levels of performance than other groups. Interestingly, teams with

high-quality performance strategies but low-quality team charters performed at a consistently "average" level. Teams with high-quality team charters and low-quality team performance strategies performed well in the beginning of the simulation; their performance dropped drastically after the mid-point.

An examination of subjective measures could have aided the researchers in understanding team dynamics as performance hovered at the "average" mark for teams with low-quality team charters/high-quality performance strategies, and dropped precipitously for teams with high-quality team charters/low strategies. The current investigation examined subjective team outcomes (team viability—the desire for members to want to work together in the future) as opposed to objective outcomes (team performance) as a consequence of team charters. Team viability, a known indicator of overall team effectiveness, is an important variable to assess in student teams. This is a particularly important aspect of team functioning in project teams in which members of the team will likely work together again in either the same class or future classes. To further expound on the importance of team viability in lower-level engineering courses, the future pool of available team members decreases up through higher-level courses as engineering students matriculate. It is very likely that these students will work together again.

Seeking to understand the impact of team charters on intermediary processes, McDowell et al. (2011) examined the relationships of varying team charter intervention levels on teamwork quality (as measured by communication, cohesion, effort, and mutual support), and team satisfaction. The authors investigated the effect on process mechanisms when teams were exposed to no team charter, a team charter lecture and

example, or a team charter lecture and follow-up support. Positive statistical significance was reported between teams that did not receive team charter exposure and (a) teams given the team charter example and assignment only; and (b) those given the team charter assignment with follow-up. No statistical significance was found for teams that received a team charter example and lesson and teams that received team charter example, lesson, and follow-up. McDowell and colleagues did not assess team charter quality as a part of their study. A potential explanation for the lack of statistical significance could be the difference in the quality of team charters between groups.

A third contribution to the literature is again drawn from both Mathieu and Rapp (2009), and McDowell, Herdman, and Aaron (2011). Neither set of authors explored why team charters had or did not have an effect on the outcomes in their study. DeChurch and Mesmer-Magnus (2010a) asserted the need for researchers to explore factors that "promote the formation of functional cognitive structures" (p. 49), such as team mental models. Hence, team charters are investigated as an instructional antecedent of teamwork mental model similarity and as a partial explanatory mechanism of the relationship between team charter and its consequences. Team mental model similarity—structural representation of team/project relevant elements that are held in common by members of the team—have been proven to explain why some teams perform at higher levels than others.

Finally, the current investigation sought to address the lack of empirical data derived from quasi-experimentation on the benefit or detriment of using team charters in the engineering discipline. Most research on this team effectiveness planning strategy has focused on theoretical frameworks and anecdotal endorsements from business courses

(Bolton, 1999; Byrd & Luthy, 2010; Cox & Bobrowski, 2000; Hunsaker et al., 2011; Marcellino, 2008; Mathieu & Rapp, 2009; McDowell et al., 2011) and private industry (Buhler, 2007; Norton & Sussman, 2009; Wilkinson & Moran, 1998). Although some data show that team charters are being used in engineering classes (e.g., Kellar et al., 2000; Moore et al., 2006; Pazos et al., 2011), these articles mention team charters or codes of cooperation as parts of larger team-based assignments and provide no details or explanations on their use. Figl (2010) offered a systematic framework to support and promote information systems student team competencies; team chartering was listed as a critical component. Team charters provide a "structural mechanism" to positively impact team performance (Cox & Bobrowski, 2000). Kapp (2009) reported students had more positive perceptions of teamwork (process) due to team charter usage.

The lack of quantitative studies on team charters in engineering student teams means that important questions cannot be answered. Further, we cannot automatically assume that findings from business classes and private industry generalize to the engineering classroom. To address the gap in the extant literature, this study provided foundational quantitative research on team charter use, effects, and consequences in undergraduate engineering education.

Research Questions and Conceptual Framework

This study was guided by the following research questions and conceptual framework.

Research Question 1

What is the relationship between *team charter quality* and *team viability* in engineering student teams?

Research Question 2

What is the relationship among *team charter quality*, *teamwork mental model similarity*, and *team viability* in engineering student teams?

A conceptual model framework of the study variables: a) team charter quality—codified set of agreed upon processes of how the team will work together; b) teamwork mental model similarity—commonality of organized mental models of relevant team-related information; and c) team viability—level of desired future work together is presented in Figure 1.1.

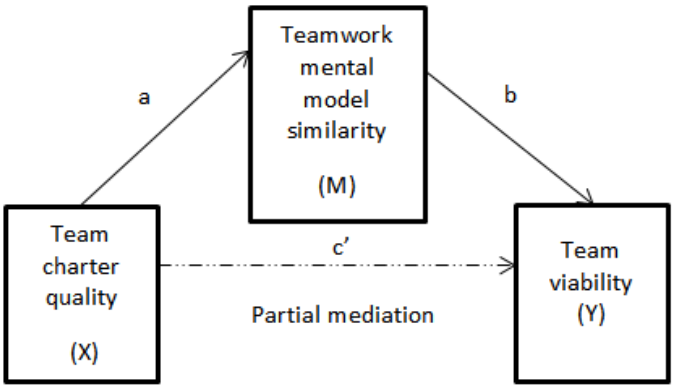

Figure 1.1. The relationship of variables in the study

Summary

Team charters have been sparsely introduced, inconsistently implemented, and largely ignored in engineering education. The extant literature is deficient of empirically tested data focused on gaining an understanding of the instructional antecedents of engineering project design team effectiveness. The contributions to be gained by this investigation were described. An introduction to the study variables and description of the hypothesized relationships were introduced. Additionally, a proposed conceptual framework was presented. More can and should be done to explicate the effect of targeted instructional activities on team effectiveness.

Chapter two offers a literature review of team charter use in post-secondary education, team viability conceptualization and its relationship to team effectiveness and teamwork mental models as a performance indicator.

Chapter 2

Review of Literature

This literature review provides an overview of the history of project teams in the engineering classroom, discussion of the main variables investigated in this study, and insight into extraneous variables based on potential internal validity issues linked to the research design.

Development of a Search Strategy

The search strategy utilized in this review involved the use of terms such as *team charter, team contract, charter quality, team effectiveness, team performance, team viability, team cognition, and team mental model.* All of the terms were used in various combinations with *engineering students, student teams,* and *engineering.*

Identification of Relevant Publications

The search was completed using Google Scholar ©, LionSearch©, and Web of Science© search tools. In addition to using the prior-mentioned search terms, Citation Map© (both forward and backward directional processes) within the Web of Science© database was also used to identify relevant data. Additional literature was identified by reviewing the reference list of articles relevant to the current study. Each article was

evaluated by reading the abstract, conclusion/summary, literature review (if included), and references. Articles were included if they identified data relevant to: (a) defining or operationalizing team charters, team viability, and/or team mental models; (b) understanding the relationship among team charters, team viability, and/or team mental models; and (c) the effectiveness of engineering student teams.

Critical Analysis and Exploration

Each article was reviewed against the two primary research questions: 1) What is the relationship between *quality* and *viability* in engineering student teams; and 2) What is the relationship among *quality*, *similarity*, and *viability* in engineering student teams? If an article did not provide insight into one of the questions, the article was set aside for later review. This set of articles was subsequently reviewed a second time and ultimately not included in this review.

Historical Perspective on Teams in Engineering Education

The National Science Foundation funded the development of the Foundation Coalition in 1993. This group of higher education institutions was tasked with developing solutions and services to meet the growing need for changes in engineering education. Student teams were a key area of support offered by the coalition. Services included introduction to student teams workshops, classroom support, and literature resources (The Foundation Coalition, 2001).

Project teams as a teaching method have been diffused into the development and re-invention of engineering curricula through the redesign and restructuring of course content, research opportunities, and departmental foci (American Society for Engineering Education, 1994). Prior to the early 1990s, working in teams, as defined in this study, was not a classroom learning expectation for engineering students. Teams were diffused into engineering curricula as a part of the student-active pedagogy "technology cluster" (Borrego, Froyd, & Hall, 2010). A technology cluster "consists of one or more distinguishable elements of technology that are perceived as being interrelated closely" (Rogers, 2003, p. 153).

Six key reports on engineering education reform were relevant to this literature review. *The report on evaluation of engineering education* (Committee on Evaluation of Engineering Education, 1955) led to higher levels of science and mathematics, inclusion of design projects, and elective humanities and social sciences topics, to promote a higher level of communication skill building in engineering curricula. Engineering education, as a whole, remained relatively static for the next fifty years. In 1994 the American Society for Engineering Education's (ASEE) *Green Report* strongly encouraged higher education institutions to accelerate their ability to produce engineers who would meet the changing demands of industry needs.

The *Green Report* was the first to address the need for team skills (American Society for Engineering Education, 1994, p. 12). Two years later the Accreditation Board for Engineering and Technology (ABET) published *Engineering Criteria 2000* (EC2000) (Peterson, 1996). EC2000 supported measuring student output rather than teaching inputs. Additionally:

> EC2000 retains earlier accreditation standards' emphases on the development of students' mathematical, scientific, and technical knowledge, as well as standards for program faculty and facilities, but it also emphasizes developing other professional skills, such as solving unstructured problems, communicating effectively, and working in teams (Lattuca et al., 2006, p. 1).

In 2005 the Committee on Facilitating Interdisciplinary Research recommended having undergraduate students seek out and enhance interdisciplinary [team] experiences through courses that spanned more than one discipline (*Facilitating interdisciplinary research*, 2005, p. 192). Also, in 2005 the National Academy of Engineering (NAE) published *Educating the Engineer of 2020* to address the perception that engineering graduates were increasingly unlikely to compete in the ever-evolving global workforce (National Academies [U.S.] Committee of Engineering, 2005). During a "Special Session-Preparing the Engineers of 2020: A Dialogue" (Terenzini, Lattuca, & Harper, 2007), three areas were discussed: design and problem-solving, interdisciplinary [team process] competence, and contextual competence.

In 2007 the Committee on Science, Engineering, and Public Policy recommended two key areas related to interdisciplinary [team process] research and teams:

- Overhaul the field-of-science classification system to take account of changes in academic research, including interdisciplinary and multidisciplinary research.

- The National Science Foundation (NSF) should engage in a program of outreach to the disciplines to begin to develop a standard concept of interdisciplinary and multidisciplinary research (National Academy of Sciences, 2007, p. 453).

The continued dedication of resources to addressing the exponential growth in complex projects encountered by engineers and/or requiring engineering solutions is directly related to the reasons for encouraging greater knowledge of team effectiveness antecedents within the engineering classroom. In a 2010 meta-analysis DeChurch and Mesmer-Magnus (2010b) found strong support of team cognition to be a foundation for effective teamwork, and specifically for behavioral processes and performance.

Team Charters

A team charter is a codified set of agreed-upon group process norms, roles and responsibilities, and team structure (Aranda, Aranda, & Conlon, 1998; Byrd & Luthy, 2010; Cox & Bobrowski, 2000; Mathieu & Rapp, 2009; Stein & Hurd, 2000; Wilkinson & Moran, 1998). Team chartering is a planning process that should be achieved early in the team formation life cycle (Aranda et al., 1998; Mathieu & Rapp, 2009). Lastly, in order for optimal team effectiveness team charters must plan for revisions and continued relevance of the document to the project (Hunsaker et al., 2011; Marcellino, 2008).

Benefits

Multiple benefits for the team and its members can be realized from team charter creation. According to Marcellino (2008), charters lead to team identification and provide a framework for implementing shared vision, performance goals, and mental model-sharing. Byrd and Luthy (2008) shared similar findings, stating that cognitive maps of processes for effective team interactions result from team charter creation. Additionally, team charter creation has been shown to enable team members to lay solid groundwork for agreed-upon processes and norms, and shared expectations, thus improving the desired outcome. Urch Druskat and Pescosollido (2002) stated that team chartering is hugely important in the assimilation of new team members; lack of a clear understanding of the team charter can increase dissimilarity among shared mental models, which can be detrimental to team effectiveness.

Team charters have been shown to influence quality of work. Student teams introduced to team chartering showed a positive and significant difference in team process quality and satisfaction (e.g., cohesion, communication, mutual support, and effort) as compared to a comparison group (McDowell et al., 2011). An additional benefit evidenced from team charter creation is long-term application throughout the student educational lifecycle (Byrd & Luthy, 2010; Hunsaker et al., 2011). The University of San Diego now requires all incoming graduate business students to complete a team charter as a part of mandatory team-building orientation; additionally, team charters are a required learning activity in all classes within the programs that use teams (Hunsaker et al., 2011).

High-quality planning was found to produce better shared mental models and hence improve performance (Stout, Cannon-Bowers, Salas, & Milanovich, 1999). In a study of military-based command-and-control, researchers reviewed team decision-making in a high-fidelity environment. Lack of planning, failure to follow plans, and failed team communication were cited as the most common team issues—27% of problems were attributed to planning failures, and 55% of total problems reported were instigated by failed communication (failure to communicate, terminological issues, lack of follow up, late communication, and excessive communication). These expectation- and explanation-related problems were linked to performance deficiencies (Rouse, Cannon-Bowers, & Salas, 1992, p. 1306). Deficiencies such as these can be minimized through team charter creation.

Charters in Action

Instructors acknowledge the complexity of infusing team effectiveness instruction into the classroom. As stated by Hunsaker et al. (2011): "It is challenging, however, to develop classroom training strategies that can expediently mold diverse sets of students into cohesive, high-performing learning teams in a single semester" (p. 127).

In their descriptive study, Cox and Bobrowski (2000) explained their attempt to improve student team effectiveness in the classroom. Initially, they employed team charters in a business management course to equip student teams with the "support and structural mechanism for aiding team performance" (para. 22). Team charter dimensions included components such as: goals, norms, decision making, and conflict. A total of 98

teams from four classes were surveyed. Students reported team charters aided in their team's performance (74% of those surveyed); 75% of those surveyed stated that team charters helped to clarify goals and objectives. Three areas of improvement were noted via the surveys: (a) teams did not use their team charters or failed to follow the rules in the charter; (b) the combined effort of team charters and team journaling was too time-consuming; and (c) charter should be re-evaluated during the project. Based on the initial team charter offering and student feedback, the authors added a second team charter assignment to the course: team charter update. Survey data were not reported for the team charter update assignment. The authors stated that equipping students in their lower division (freshmen) courses with team charter skills would be of great value as those students used those skills in other team-based courses. Cox and Bobrowski (2000) and Hunsaker et al. (2011) both reported that implementing team charters in the class had minimized many of the common pain points for student teams: poor communication, lack of decision-making processes, social loafing, and unresolved conflict.

Hunsaker et al. (2011) shared, via a descriptive study, how team charters and a "damage" management model were used in an undergraduate business team-based course to "enhance student learning team effectiveness early in the semester" (p. 127). Like Cox and Bobrowski (2000), Hunsaker and colleagues assigned points for team charter completion. However, one key addition from Hunsaker et al. was the introduction of a team charter rubric. Each component (i.e., mission statement, team identity, and boundaries) of the team charter was assigned points; 100 total points were possible. Team charter assignment and usage feedback were collected via student survey. The survey scale was as follows: 1 (strongly agree) to 7 (strongly disagree). Hence, the scores

reported seemed low relative to most other surveys. Students "fairly strongly agreed" that team charters: (a) contributed to the success of team functioning (2.72); (b) clarified goals and objectives (2.3); and (c) helped with member participation (2.54). Complaints about the assignment reported by students included the following: (a) the charter did not influence the team because the members did not "revisit or consult it after it was created" (p. 139); (b) well-organized students wouldn't need a team charter; and (c) teams felt they were graded unfairly because of missing elements in their team charter. Improvements, as recommended by the students, to the team charter assignment included: (a) future teams should revisit their charters; (b) add specific meeting times and assignments to the document; (c) add a signature page; and (d) provide in-class time to conduct team introductions and share their team logos.

The two descriptive studies were implemented in the classroom for the sake of improving student team experiences. Two empirical studies of team charters are described next—only one of these was commissioned for education improvements. There is an apparent gap in the team charter literature on empirical demonstrations of team charters conducted in the classroom for the benefit of student teams. The current investigation provided such a study.

Empirical Evidence

McDowell et al. (2011) examined the effects of various team charter treatments on teamwork quality and member satisfaction among undergraduate business students working in semester-long project teams. Communication, effort, mutual support, and

cohesion were used to operationalize teamwork quality and member satisfaction. The study consisted of three manipulations: (a) group one—received no team charter information; (b) group two-—received a team charter example and subsequent assignment; and (c) group three—received a team charter example and assignment, and instruction and follow-up. Statistically significant differences for all variables (communication, effort, mutual support, and cohesion) were found between teams that did not receive any team charter information or assignment (group one) and teams that received a team charter example and subsequent assignment (group two). Positive statistically significant differences were reported across all variables between teams that did not receive any team charter information or assignment (group one) and teams that received a team charter example and subsequent assignment and instruction and follow-up (group three). However, no statistically significant differences were observed for the two groups that received some level of team charter instruction (groups two and three). While the study by McDowell et al. (2011) provides empirical support for the use of team charters in educational environments, it does not explain why teams exposed to team charters reported higher-quality and member satisfaction. Additionally, the data were collected at the end of the semester-long project; the study could have been strengthened by collecting data on multiple occasions.

The team charter empirical/experimental record was started by Mathieu and Rapp (2009). The authors investigated the effects of team charters and performance strategies on long-term performance in a simulation using undergraduate business students. Charter dimensions included: (a) individual preparation, (b) team roles, expectations and processes, and (c) rewards and sanctions. Team charters produced a non-significant but

positive correlational effect early in the simulation; the strength of the relationship continued to increase throughout the simulation. The quality of team charters was assessed for completeness and consistency. Each team received a score out of 100 points. All members of the team were given the same grade. Results from the study demonstrated that performance strategy quality was the main driver of long-term performance. Teams with high-quality performance strategies outperformed teams with low-quality strategies. However, team charter quality did interact with performance strategy quality. This was evidenced by teams with high-quality performance strategies but low-quality team charters underperforming compared to teams with both high-quality performance strategies and high-quality team charters.

Team Charter Quality

The current investigation defined team charter quality as consistent and comprehensive. This is consistent with Mathieu and Rapp's (2009) conceptualization of high-quality team charters. High-quality team charters have been shown to increase effective communication, enable teams to be better prepared for larger workloads, and manage more efficiently to avoid errors during complex work episodes (Stout et al., 1999).

There is a distinct lack of research on the quality of team charters as an input and its relationship to team output. A few exceptions are: Mathieu and Rapp (2009), who found significant interactions between team charter quality, measured as a score out of 100 possible points, and performance; Marcellino (2008), who vaguely mentioned team

charter quality as a predictor of team performance; and McDowell et al. (2011, p. 82), who stated that "planning tools" such as team charters should be high quality. In alignment with past literature, Stout et al. (1999) identified nine markers of high-quality planning (e.g., exchanging preferences and expectations). However, Weingart (1992) stated that the quality of the plan may be a better predictor of team performance than the quality of the planning process**.** The current investigation examined whether higher-quality team charters positively influence team interactions and correlate with higher levels of desire to work together in the future.

This benefit as identified throughout the team charter literature is intuitively appealing to engineers and will counteract the potential for such issues to be ignored in the team formation phase. An important question was asked by Rouse and colleagues (1992): "How do we manipulate mental models to improve performance?" (p. 1301). Taking the time to discuss and agree on team charter components, specifically on expectations, norms, roles and responsibility, resource allocation, and communication standards, will help teams set key team performance-related processes in motion (Wilkinson & Moran, 1998), jump-start norms that increase group functioning behaviors (Cox & Bobrowski, 2000), and set high information-sharing precedents (Aranda et al., 1998) to increase the likelihood of team effectiveness.

Team Viability

Defining Team Viability

Team effectiveness is comprised of team viability (social and personal factors) and team performance (job- and duty-related factors) (Balkundi & Harrison, 2006; Guzzo & Shea, 1992; Hackman, 1987). Team viability has been consistently investigated as one of the two primary dimensions of team effectiveness. This trend started with the seminal theoretical study by Hackman (1987), who was responsible for one of the most quoted justifications for using team viability as a team effectiveness criterion: "Some groups operate in such a way that the integrity of the group as a performing unit is destroyed; the group 'burns itself up' in the process of performing the task" (p. 323). Hackman himself stated that the inclusion of "social" dimensions of team effectiveness was a departure from the custom of defining team effectiveness solely as the output of the team. Ultimately, Hackman's 1987 criterion of team effectiveness introduced team viability as the team's capability for future work.

Sundstrom, de Meuse, and Futrell (1990) used an ecological approach to develop a work team effectiveness conceptual framework. The basic premise of the ecological perspective is realizing that a team's effectiveness is related to the larger organization in which the team functions. Sundstrom and colleagues identified four key overlapping areas of team effectiveness: organizational context, boundaries, team development, and team effectiveness. Team effectiveness was operationalized as team performance and team viability by Sundstrom et al. By employing both performance and viability, the authors advanced the idea that team effectiveness encompasses more than just the final

product of the team. Team effectiveness embodies the "what" a team produces as the output and the "how" (behaviors and/or processes used to generate the "what"). These behaviors impact team members' desire for future work together—team viability.

Team viability, for the purpose of this study, was conceptualized based on Hackman's (1987) definition: capability of future work.

Team Viability and Team Effectiveness

Team viability is a marker of future team performance (Bell & Marentette, 2011) and effectiveness (Tekleab et al., 2009). As such an understanding of the instructional antecedents of team viability is useful in building a logical path to improving team effectiveness. Bell and Marentette (2010) identified team viability as a "proximal team effectiveness criterion" (p. 280). Teams that share common norms, rules, and processes will typically enjoy a high rate of team attachment and desire to work together in the future. Resick et al. (2010) demonstrated that teams with similar task mental models had greater team viability. Additionally, Resick and colleagues stated that team mental model similarity is important to team viability since the similarity of task mental models could lead to similar teamwork mental models. The authors believed that increased team viability could stem from reduced conflict, better interpersonal interaction and higher levels of psychological safety—"a shared belief held by members of a team that the team is safe for interpersonal risk taking" (Edmondson, 1999, p. 350).

Resick et al. (2010) examined the similarity and accuracy of task mental models only. They reasoned that newly formed teams must quickly develop "a shared

perspective" of "actions, equipment, and procedures" as a crucial first step in team formation (p. 175). The current investigation viewed the beginning actions of newly formed teams differently. Mathieu and Rapp (2009) demonstrated that teams need to proactively plan for taskwork as well as teamwork to set a solid foundation for high performance. The current study did not examine taskwork mental models because taskwork is typically assessed via the highly technical and prescriptive grading rubric of engineering student design projects. Lastly, entry-level students in engineering will work together again as they matriculate through their educational cycle. Therefore, team viability, as defined here, was important to this research through its focus on improving freshmen engineer team-related experiences in the hopes of ensuring that their newly acquired skills will aid them in future team-based classes and projects. Additionally, the current investigation addressed Bell and Marentette's (2011) call for future research on relevant team viability antecedents.

Team Mental Models (TMM)

Team mental models are a form of team cognition. The term has been utilized to explain the difference observed in high performance military command and control teams. Conceptually explained further, team cognition "separates effective teams from ineffective teams" (Cannon-Bowers & Salas, 2001, p. 196).

Shared or team mental models are one of the most researched types of team cognition (DeChurch & Mesmer-Magnus, 2010a). Early work in mental model research centered on four key areas: (a) equipment, (b) task, (c) team interaction and team, and (d)

task and team knowledge. Of specific interest is the power of shared expectations and coordination (Rouse et al., 1992). Rouse and colleagues believed mutual expectations and coordination lead to improved performance. Initial conceptual studies on TMM linked the construct to those elements that made some investigated teams more successful than others. Rouse et al. (1992) stated that mental models or shared models are constructs invoked to explain performance differences. High-performing teams were said to enable members to view work through a "common lens" (Resick et al., 2010) and shared coordinated understanding that positively impacted their work (Cooke, Salas, Cannon-Bowers, & Stout, 2000). Team mental models influence performance via commonly understood expectations, coordination, and communication standards (Rouse et al., 1992, p. 1302); enable members to use a common knowledge base in times of decision making (Cooke et al., 2000); and have been shown to be a predictor of team effectiveness and team performance for high-performing teams (Burtscher, Kolbe, Wacker, & Manser, 2011; DeChurch & Mesmer-Magnus, 2010a, 2010b; Mohammed et al., 2010).

The team mental model is an emergent state (DeChurch & Mesmer-Magnus, 2010a; Marks, Mathieu, & Zaccaro, 2001). Emergent states, as introduced and defined by Marks et al. (2001), are "constructs that characterize properties of the team that are typically dynamic in nature and vary as a function of team context, inputs, processes, and outcomes" (p. 357). Additionally, features of team mental models have been characterized into three areas: content domain, properties, and form of cognition (see Table 2.1) (DeChurch & Mesmer-Magnus, 2010a; Mohammed & Hamilton, 2011).

Table 2.1

Features of Team Mental Models

Category	Characteristics	Elements
Content domain	Teamwork	How the work gets done (Mohammed & Hamilton, 2011).
	Taskwork	What work needs to get done (Mohammed & Hamilton, 2011).
Properties	Similarity	The amount of likeness or overlap of members' mental model (Mohammed & Hamilton, 2011).
	Accuracy	The amount of convergence of members' mental models with that of the expert model (Mohammed & Hamilton, 2011).
Form of cognition	Structural	Organization of teams' knowledge (DeChurch & Mesmer-Magnus, 2010b, p. 36).
	Perceptual/Belief	Beliefs, attitudes, and values (DeChurch & Mesmer-Magnus, 2010b, p. 36).
	Elicitation	How the knowledge is captured (Mohammed et al., 2000).
	Representation	Visual structure of the relationship (Mohammed et al., 2000).

Note. Characteristics relevant to the current investigation are located in the shaded cells.

Team Mental Model Characteristics

Team Mental Model: Content Domain

The team mental model content domain consists of teamwork and taskwork, as well as team interaction processes such as "roles/responsibilities information flow and sources, communication channels, role interdependencies" (Mathieu, Heffner, Goodwin, Salas, & Cannon-Bowers, 2000, p. 275) and team-specific awareness, including "knowledge, skills, abilities, tendencies, and preferences" (Mathieu et al., 2000, p. 275). Technology- and job-related responsibilities in the taskwork mental model include:

operating procedures, system limitations, task strategies and procedures, and environmental considerations (Mathieu et al., 2000).

The team mental model characteristics used in this study were concerned with teamwork as opposed to taskwork mental model similarity. Due to the highly technical nature of engineering course content, taskwork mental models may be effectively addressed via project assignments (typically outlined in great detail in the syllabus or other course documentation) and instructor. However, faculty members rarely assist students in navigating themselves toward effective teamwork (Adams, 2003). Successful engineer practitioners must possess more than technical competence: "an engineer is hired for her or his technical skills, fired for poor people skills, and promoted for leadership and management skills" (Russell & Yao, 1996, p. 18).

In a study conducted by Marin-Garcia and Lloret (2008) on preventing student shirking in engineering student teams, it was noted that instructors must attend to factors and processes that impact students' feelings and motivation. If these important issues are left unattended, then negative team behaviors such as loafing could derail team effectiveness. Teamwork mental models encompass intrateam norms, behaviors, and social cues and define team processes that direct members' actions to accomplish taskwork (Cannon-Bowers, Salas, & Converse, 1993) in a cohesive manner. Also, the teamwork mental model is thought to be more "generalizable" to teams regardless of task or function (Fisher, Bell, Dierdorff, & Belohlav, 2012, p. 827). Therefore, the teamwork mental model was selected for study for its ability to strengthen students' "people skills" as well as provide a "transportable" skill to support effective teamwork.

Team Mental Model: Properties

Similarity (sharedness) and accuracy (likeness to expert referent) are the two properties of team mental models. The degree to which members' mental models are consistent with one another is measured as similarity (Mohammed & Hamilton, 2011) as compared to the degree to which members' mental models align with the designated experts' model or "true score" (Mohammed & Hamilton, 2011, p. 96).

Team cognition researchers tend to identify team mental model properties interchangeably using the terms similarity, convergence, and sharedness. The basic premise of similarity is a team's ability to have a collective perspective on the "what" and "how" of team achievement. Work by Rentsch and Hall (1994) and Rentsch and Klimoski (2001), which emphasized similarity as compared to "shared", was selected to reflect the commonality rather than identical nature of student teamwork mental models.

The property of team mental model accuracy—highly convergent with the expert model—has been empirically linked to performance improvements (Lim & Klein, 2006; Mathieu, Heffner, Goodwin, Cannon-Bowers, & Salas, 2005; Smith-Jentsch, Cannon-Bowers, Tannenbaum, & Salas, 2008). However, Edwards, Day, Arthur, and Bell (2006) showed that accurate team mental models would be most predictive when the option of a "true score" or a very limited list of options is feasible. Team mental model accuracy is typically concerned with the shared overlap with the expert or "true score", not that of sharedness among team members (DeChurch & Mesmer-Magnus, 2010a). The current proposed study focused on aligning team members' teamwork mental models. Hence, similarity as opposed to accurate teamwork mental models was the cognitive property

focus of this study. The goal was to acquire a "common lens" (Resick et al., 2010, p. 5) regarding "how" to get the work done—a quality that student teams often lack (Adams, 2003).

Team Mental Model: Form of Cognition

The third element of team mental models, form of cognition, consists of two categories: structured or perceptual forms; and elicitation and representation. Structured cognition "focuses on the pattern of knowledge arrangement, then models the collection of knowledge patterns within a team (DeChurch & Mesmer-Magnus, 2010b, p. 36), as opposed to models of perceptual cognition concerned with attitudes, expectations, and values (DeChurch & Mesmer-Magnus, 2010b, p. 36). The second cognition category is elicitation—how the knowledge is captured; and representation—the visual structure of the relationship. The team mental model is the only form of cognition to achieve both elicitation and representation (Mohammed et al., 2010).

The team mental model domain is typically measured as knowledge structure associations. Knowledge structure as opposed to belief structure was selected as the domain (form of cognition) for this study. Knowledge structured cognition models the organization of members' understanding of team-related contextual matters. Essentially, structured cognition measures and models the "pattern of knowledge" (DeChurch & Mesmer-Magnus, 2010b, p. 36) as opposed to what is "desired" or "wanted" (Mohammed & Hamilton, 2011, p. 139). Additionally, according to Mohammed, Klimoski, and Rentsch (2000), knowledge structures are likely to be developed earlier in

the team development cycle than belief structures; and are more stable (p. 126). Hence, using knowledge structure as a proxy to examine what student team members "know" about their intrateam interactions and scope of work was most relevant for the study.

20 Years of Team Mental Models: Antecedents, Mediation, and Team Effectiveness

Antecedents

Mohammed et al. (2010) conducted an in-depth review entitled, "*Metaphor no more: A 15-year review of the team mental model construct*." The work of Mohammed and colleagues reflects findings and observations in the team mental model literature up to 2010. Key findings from their work are categorized into three areas directly related to the current investigation: antecedents, mediator, and team effectiveness.

Mohammed et al. (2010) offered an overview of team mental model antecedents. The overview was categorized into three "broad…drivers: members characteristics, team level interventions, and contextual factors" (p. 896). Team-level interventions, such as planning, were of specific interest to the current study. In their review of 15 years' worth of team mental model literature, only one article on the antecedent relationship between planning and team mental models (e.g., Stout et al., 1999) was cited. This lack of supporting literature is not an authorial omission; it is due to the lack of published articles on this topic.

In a another compilation study, a meta-analysis, (DeChurch & Mesmer-Magnus, 2010a) also cited a "insufficient number of studies" concerning the relationship between

planning and team mental models. However, the authors collapsed other process constructs into one: team process overall. It was determined that team mental models were predictive of team performance. One caveat was DeChurch and Mesmer-Magnus (2010a), who investigated planning as a moderator to the team process-team performance relationship, whereas Mohammed et al. (2010) reviewed planning as an antecedent of team mental models.

Zhou and Wang (2010) reported a significant interaction between team processes and teamwork mental models; processes in the study included planning and strategy formulation. Both were categorized using the transition phase definition of Marks et al. (2001). The transition phase as defined by Marks et al. consists of times when members are focused on planning and evaluative events that will enable them to accomplish the team goal (p. 364). Team processes such as planning and strategy development have been empirically linked to influences on mental model similarity (Gurtner, Tschan, Semmer, & Nägele, 2007). Gurtner et al. tested reflexivity, looking at past performance and processes to identify areas for enhancement, interventions' impact on team performance, and mental model similarity. The intervention used a three-stage process: (a) reflection on performance to discover needed improvements, (b) planning, and (c) implementation (Gurtner et al., 2007, p. 128). The authors reported a significant main effect in that mental models were more similar in the reflexivity treatment conditions than in the comparison condition.

In a more recent study Van den Bossche, Gijselaers, Segers, Woltjer, and Kirschner (2011) reported that the co-construction ("mutual process of building meaning", p. 287) of knowledge was potentially detrimental to the development of team

mental models. Their premise was based on the idea that teams not only needed to co-construct knowledge, but to negotiate and agree upon the knowledge.

By examining the relationship among team charters, a specific component of planning, and team mental models, the current investigation addressed identified gaps in the existing team effectiveness literature such as: identifying tools that will increase team mental model similarity (Mohammed et al., 2010, p. 901); and creating team-level opportunities for members to not only co-construct knowledge, but to negotiate and agree upon it (Van den Bossche et al., 2011).

Mediation

Team mental models have been described as a mediator of team effectiveness for the last twenty years (Cannon-Bowers et al., 1993; Mohammed et al., 2010). However, very few studies have been conducted on the mediational relationship. Only three such studies were cited in Mohammed et al. (2010) (i.e., Edwards et al., 2006; Ellis, 2006; Rentsch & Klimoski, 2001). Rentsch and Klimoski (2001) investigated the mediational effects of teamwork member schema agreement, defined as "the degree to which team members have similar or compatible knowledge structures for organizing and understanding team-related phenomena" (p.108). According to Rentsch and Klimoski (2001), three of the five subsets of variables fully mediated the relationship between antecedents and team effectiveness variables: (a) percentage of high-experience team members and member growth and (b) team viability; and (c) percentage of team members

recruited and team viability. The relationship between team experience and overall effectiveness only demonstrated partial mediation.

Edwards et al. (2006) looked at the taskwork mental model as opposed to the teamwork (process) mental model; hence, the study was not included in this review of the literature. Ellis (2006) found that the team interaction mental model, defined as accounting for team-centered actions, partially mediated the relationship between acute stress and team performance in command and control simulations. Ellis reported high levels of stress that acted to interrupt team mental models such that team performance was reduced. Lastly, Cartaya (2012) explored the individual student mental model as a mediator between personality and performance. Agreeableness, defined as high levels of trustworthiness and integrity, and extraversion, defined as high sociability, and need for externally driven activity, positively related mental model sharedness with the instructor. While the study did not include a team-level intervention, it did show evidence of interest in understanding the role of student mental models and instructor mental model alignment. Cartaya's research highlighted an important link between mental model formation and instructor (classroom) interactions.

Team Effectiveness

A vast number of studies have demonstrated the predictive outcome power of team mental models (DeChurch & Mesmer-Magnus, 2010a). However, as noted by Mohammed et al. (2010), very few team effectiveness indicators outside of team performance have been produced in the extant team mental model literature. Of the 11

studies highlighted in the antecedents section of Mohammed and colleagues' 15-year review of team mental model literature, only one included team viability as an outcome.

In a recent study Van den Bossche et al. (2011) found that team task mental models did improve the performance of students on a business simulation. The authors stated that future research should investigate the relationship between mental models such as "mental model of the team or team interaction" (p. 297) and different aspects of team effectiveness. The current research addressed research recommendations in Van den Bossche et al. (2011) by examining teamwork mental model similarity as a mediator of the team charter quality and team viability relationship.

Measurement

Concept maps were originally proposed as the measurement tool for this study; however, student engineering teams do not have consistently assigned roles across all teams to facilitate the hierarchical nature of concept maps (Klimoski & Mohammed, 1994; Mohammed et al., 2010); hence, concept maps were dropped from the study. Subsequently, similarity ratings were selected as the data collection method due to their benefit in eliciting cognitive content and high validity, and high test/retest validity (Mohammed et al., 2010).

Similarity ratings are the most direct methods used to rate terms/concepts of an individual's cognitive structure (Jonassen, Beissner, & Yacci, 1993). Additionally, this method is also one of the most popular team mental model measurement techniques (Mohammed et al., 2010). These ratings judge the relatedness of terms within a defined

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context. Terms should be context-specific (Cooke, 1994; Jonassen et al., 1993; Klimoski & Mohammed, 1994), drawn from experts within the specified area (Jonassen et al., 1993), and help those rating the terms to understand the "general range of relationships" (Jonassen et al., 1993, p. 40).

Two similarity ratings methods were reviewed for this investigation: pairwise and listwise. Pairwise rating is the most commonly used elicitation method. However, one consequence of using pairwise similarity ratings is potential participant fatigue when more than 20–25 terms are compared (Clariana, 2010a, 2010b; Cooke, 1994; DeChurch & Mesmer-Magnus, 2010a). Pairwise ratings require a much larger number of pairings to be made: n (n-1)/2; n equals the number of terms to be paired (e.g., an n of 24 equates to 264 decisions). Participants using listwise similarity match ratings on a one to two ratio; 24 terms require 48 pairings.

Clariana and Wallace (2009) tested and assessed a multi-decision approach of elicitation. Pairwise, listwise, and concept sorting elicitation methods were measured in parallel. A few key findings from his investigation included the following: (a) listwise paired ratings were shown to more significantly depict linear, defined as serially contiguous, constructed mental model content than pairwise and cluster; (b) paired ratings had a stronger interaction of organization and format of non-linear (included in a contiguous lesson, but not previously represented in a linear array) similarity data; and (c) group relatedness ratings were more strongly correlated than individual ratings. The combination of the two methods was shown to have "better concurrent validity" and a higher level of reliability as compared to pairwise (Clariana, 2010b, p. 56). An additional benefit of using listwise and concept sorting together is a condensed participant

completion time as compared to pairwise. This is due to the reduced number of ratings made when using listwise as compared to pairwise. Clariana (2010a, p. 51) reported that the multi-decision approach using 15 terms proved to require less time than using pairwise. Participants used 308.8 s (SD = 142.3) with the listwise and term-sorting combination as opposed to 447.4 s (SD = 140.6) via pairwise (p. 51). Although the combination of listwise and concept sorting combination was very effective in the Clariana study, only listwise was used to elicit knowledge in the current investigation. This was done to minimize participant fatigue; three other data collection instruments were administered in the same time period as the listwise ratings.

Pathfinder was used to analyze the structure and represent the similarity in members' team mental models. Both multidimensional scaling (MDS) and Pathfinder (PFNET) use data reduction and representation methods (Clariana, 2010b). However, the decision was made to use Pathfinder (PFNETs) as opposed to MDS because PFNETs display links between terms—the shorter the link, the more the terms are related, representing local network structures (Edwards et al., 2006), and using the most salient data to create a connected graph (Clariana, 2010b). Essentially, Pathfinder PFNETs are more visually intuitive than MDS Euclidean Distance Model visual depiction. DeChurch and Mesmer-Magnus (2010a) found strong support predictive power in a similar mental model for team processes. These relationships were strongest with similarity ratings; Pathfinder was used to represent the mental model, and Pathfinder C was used as the measurable index of similarity (DeChurch & Mesmer-Magnus, 2010b, p. 9).

Pathfinder consists of three steps. During step one raw proximity data were collected via relatedness ratings (see Appendix A). Step two involved interpreting the

raw proximity data using Knowledge Network and Orientation Tool software (KNOT) (Schvaneveldt, n.d.). KNOT uses the data proximities to visually represent the data in a network (a PFNET) (Schvaneveldt, n.d.). The PFNET consists of least-weighted paths to connect all terms (Clariana, 2010a). Step three entailed using KNOT software to compare the PFNETs of individuals or teams to a referent's PFNET.

The "common" or number of links shared by two PFNETs (Clariana, 2010a) measure of similarity was used to indicate stated agreement within the team (DeChurch & Mesmer-Magnus, 2010a).

Control and Extraneous Variables

Instructor influence and prior team and team charter creation experience were used as control variables. Data were collected in four sections of EDSGN 100 (course title). The four sections were taught by two different instructors. Each instructor was assigned to both a comparison and treatment section to minimize variance due to differences in instructor teaching styles and capabilities, and different team composition methods.

Espey (2010) stated that students' prior experience on teams significantly influence members' initial attitudes toward future team processes. Also, negative team experiences can corrupt a student's attitude toward future team experiences (Adams, 2003). Individual differences in knowledge structure are captured via similarity ratings, and these differences in prior understanding will affect members' ratings (Jonassen et al.,

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1993). Hence, prior team and team charter creation experience were used as extraneous variables.

Summary

The benefits of team charters are well documented in business schools and in private industry. Team viability is important in engineering student teams. Members are likely to work together again, in a team-project based class, due to 30%, on average, of freshmen and sophomores leaving the engineering discipline. Teamwork mental models have been shown to strengthen “people skills” and aide in developing effective team processes. Based on the literature review of these key areas there is a need within engineering education to examine and understand the relationship among team charter quality, teamwork mental model similarity in student teams, and team viability.

Chapter 3

Method

The purpose of this study was to examine the relationship among team charter quality, team viability, and teamwork mental model similarity in an undergraduate engineering course. A nonequivalent groups pretest-posttest design was used to examine the relationships.

Engineering Design 100 Course

Engineering Design (EDSGN) 100 is one of the first courses pre-engineering majors take in their freshman year. This 3-credit introductory design-centered engineering course focuses on design communication skills (graphical, verbal, and written), computer-aided analysis tools, and teamwork. The premise of the course is to introduce students to the engineering approach to problem-solving. Multiple sections (on average 22 regular and one honors section) are offered each spring, summer, and fall semester. The classes meet for one hour and fifty minutes three times per week, for a total of five hours and fifty minutes. Weekly classes typically consist of two lectures and one lab session.

Students in the class were required to complete two separate design team-based projects. Typically, members served on the same team for both assignments. The projects required a combined total of 30 hours of in-class work (one-third of the course). Project

one accounted for 15% (stand-up presentation, 5%; project report website, 10%), and project two accounted for 30% (stand-up presentation, 10%; project report website, 20%) of each student's grade. Only the first class project was included in this study. Teamwork was subjectively measured by the instructor and peer evaluations. Students could improve their overall course grade by 2%; poor teamwork could decrease the overall grade by the same percentage. However, prior to the implementation of this study, as is traditional in many engineering courses, no documented efforts were made to instruct students in team process effectiveness.

Sample

An overview of the study was emailed to the EDSGN 100 instructor team. Three instructors initially expressed interest in the study; however, one of the instructors taught the honors section. There is only one section of honors EDSGN 100 per semester. The decision was made not to pursue the honors section because there was not a comparison section of honors participants to compare with the treatment section. Additionally, the content for the honors section and standard section of EDSGN 100 were not comparable.

Participants either served in the treatment or comparison group based on the section of EDSGN 100 each selected for their schedule. Participants were unaware of the research study at the time they enrolled in their respective sections of EDSGN 100. A total of 128 undergraduate students (divided into 32 teams; each team consisting of four students) from four sections of EDSGN 100 participated in the main study.

Treatment and comparison sections were arranged by time of day. The manipulations were counterbalanced to minimize the negative impact of time of day as a confounding variable. Classes taught by instructor "A" were assigned a morning treatment and afternoon comparison. Conversely, instructor "B" was assigned morning comparison and afternoon treatment.

To minimize changes in team size and make-up, teams were assigned during the third week of class. This timeframe is after the University's normal course drop/add period (usually the 11th day of the semester) had expired.

The instructor for comparison section "A" and treatment section "A" assigned teams based on results from a student preference/experience class survey; family relationships; and surface-level diversity. Sample survey questions included the following: "Hands-on building experience: (a) not sure, (b) minimal, (c) fair, (d) good, (e) excellent"; open-ended questions included: "Describe your experience of working in teams (academic, sports, other)". Siblings were assigned to different teams. Actions were taken to distribute various components of surface-level diversity—observable or known differences such as race, gender, or educational background.

Instructor "B" assigned teams by having students count off one through eight. Each number represented a team; students were assigned to their team based on the order of the numbers.

Variables

Dependent Variable: Team Viability

Team viability, defined as the willingness to take on future assignments together, is important to students enrolled in the freshmen engineering introduction class because they complete multiple design-related projects. Additionally, students in these classes will likely work together again as they matriculate through their engineering courses. Therefore, capturing desired future collaboration is essential to overall team effectiveness.

However, team viability as a construct is still operationalized inconsistently. Barrick, Stewart, Neubert, and Mount (1998) investigated how ability and personality affect team performance, and defined and operationalized team viability as a desire to complete existing teamwork. Barrick et al. (1998) used team viability scales created by DeStephen and Hirokawa (1988) and Evans and Jarvis (1986) to collect data from supervisors. Satisfaction, social cohesion, and intent to stay were used to operationalize crew (team) viability in Tesluk and Mathieu's (1999) study of how maintenance and construction work crews manage performance barriers. Diversity, efficacy, conflict, and perceived performance as predictors of members' intent to remain with their team, loosely defined as team viability, were investigated by Bayazit and Mannix (2003). Bushe and Coetzer (2007) defined team viability as two dimensions of satisfaction. Satisfaction with membership and output satisfaction were both measured as dimensions of team viability. Bushe and Coetzer (2007) stated that their intent was to maintain

alignment with Hackman's (1987) theory of future work orientation (output satisfaction) and members' personal development needs (membership satisfaction).

Hence, the current investigation used two scales: Jehn, Greer, Levine, and Szulanski (2008) and Tekleab et al. (2009), both of which measure members' desire to take on future work as a team. Team viability was operationalized using two team viability items from Jehn et al. (2008). The decision to use two of the four items was made because only two of the four related directly to team viability as defined in the current study. Items included: "To what extent would you like to participate in another task with the same team members?"; and "If you could have left this team and worked with another team, would you have?" (reverse-coded) (Jehn et al., 2008, p. 480). Sample items from Tekleab et al. (2009, p. 199) included: "This team should not have continued to function as a team?" and "I would be happy to work with the team members on other projects in the future." Items were rated using a 7-point Likert-type scale.

Individual member team viability score—coded as *viability* for data analysis—was an average of their survey items. Each team's viability score was calculated by combining the individual member score of the team using the mean value. The scores could range 1.0 (very low viability) through 7.0 (very high viability). Team viability data were collected as interval data. Jehn et al. (2008) documented an alpha of .82 for this team viability scale; Tekleab et al. (2009) reported a .89 reliability coefficient .

Independent Variable: Team Charter Quality

Half of the study sample (*n* = 16*)* received the treatment—team charter assignment. The other half (*n* = 16)—the comparison section—did not. Charters were evaluated on a scale of 100 points based on work by Hunsaker et al. (2011) (see Appendix B). Each item on the rubric was worth from five to ten points, for a total of 90 points. Teams received five points for handing in a signed copy of their team charter. An additional five points were earned by submitting the team charter via the class drop box. All teams, regardless of treatment or comparison section designation, received team charter quality scores—labeled as *quality* for data analysis. Teams completing charters received a quality score (1 to 100 points) based on the charter submitted by the team. Teams not completing team charters received a quality score of zero ("0").

Charters were evaluated on completeness and consistency. The team charter lesson consisted of four main dimensions: (a) *individual background;* (b) *mission statement and team goals;* (c) *roles and processes;* and (d) *performance agreement.* Each main category comprised sub-dimensions as listed in Table 3.1. Complete team charters addressed all four dimensions as well as each of the sub-dimensions. Charters were reviewed two times—once by the principal author and once by a reviewer masked to the purpose of the study. Consistency related to appropriate parallels within the charter document. As an example, the team could state that they would rotate the note-taking role in the roles section; however, they could contradict their own statement by listing only one name in the role of note-taker in a subsequent section. *Quality* scores were an

average of the scores from the two reviewers. This method was used by Mathieu and Rapp (2009).

For the initial data analysis, *quality* of 90 points or higher equated to "high" quality; charters scored as 80–89 points were designated as "relatively high"; scores between 70–79 were labeled as "relatively low"; and charters scored at 69 points and lower were assigned as "low" quality. Teams not creating a team charter, the comparison section, were assigned zero *quality* points.

Table 3.1

Four Dimensions of Team Charter

Four Dimensions	Sub-dimensions
Individual background	*Provides an introduction of each team member to their team.* Personal background and project related strengths and weaknesses. Contact information and preferred medium(s) (text, e-mail, etc.). Availability and preferred work times. Develop a team calendar that includes: Each team members' name, phone number, e-mail address and team member availability.
Mission statement and Team goals	*Provides a unified identity and shared view of desired team destination.* Team purpose (this is your mission statement). What team goals do you need to accomplish to attain your mission?
Roles and Processes	*Provides agreed upon team behavioral norms.* Do you need a leader? What is expected of your leader? Will you rotate leadership? How will you assign or select roles, other than leader, for the team? How will you handle meeting action items and written follow-up? How will you make decisions: most vocal wins, voting, consensus (100% agree)? How will you keep track of milestones and status checks within the team and with external stakeholders?
Performance Agreement	*Provides expected actions for non-performance.* How will you deal with people for not adhering to team norms? How will you deal with dysfunctional behaviors, e.g., missing or being late to a meeting, dominating, withdrawing, wasting time, etc.?

Based on work by Hunsaker et al. (2011)

Mediating Variable: Teamwork Mental Model Similarity

The list of terms was co-created with the EDSGN 100 course instructors (see Appendix A for a list of items). Initially, two distinct areas of terms were identified: (a)

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steps in engineering design (e.g., analyze design, fabric test, etc.) and (b) team charter categories and sub-categories (e.g., work preferences, decision making, etc.). After further discussion the decision was made not to use the steps in the engineering design as similarity ratings. This was decided for two reasons. The engineering design terms represented a task mental model, not teamwork. Second, team charter creation is not an instructional antecedent of the engineering design stages. Jonassen, Beissner, and Yacci (1993) stated that similarity ratings should consist of "limited domains" and not "mix and match a broadly divergent range of related pairs" (p. 2). By doing so the researcher would limit possible distortion in the relationships of similarity ratings.

The list of terms was selected based on common dimensions of team charters from the literature: (a) *individual background* (Cox & Bobrowski, 2000; Hunsaker et al., 2011; Mathieu & Rapp, 2009); (b) *mission statement and team goals* (Hunsaker et al., 2011; Marcellino, 2008; McDowell et al., 2011); (c) *roles and processes* (Hunsaker et al., 2011; McDowell et al., 2011; Norton & Hale, 2012); and (d) *performance agreement* (Cox & Bobrowski, 2000; Hunsaker et al., 2011; Mathieu & Rapp, 2009). The list of terms was presented to and approved by the EDSGN 100 instructors.

Team mental model measurement methods used in the current study were based on work by Clariana and Wallace (2009), Clariana (2010a), Lim and Klein (2006), Marks, Sabella, Burke, and Zaccaro (2002), and Stout et al. (1999). Each team member's mental model was generated from their relatedness ratings using *Pathfinder*. Participant's raw relatedness ratings were transformed into prx files via an Excel computation process derived from the work of Clariana and Wallace (2009) and Clariana (2010b). Next, *Pathfinder* was used to generate Pfnets. The Pfnets were used to calculate an overlap

index among the networks of all members on a team. Teamwork mental model percent overlap—labeled as *similarity*—defined as links in common in two pfnets divided by the average links in the two pfnets. The values of overlap range from 0 to 1, with 1 being perfectly overlapped. An *overlap* score of .30 translates to a 30% overlap in teamwork mental model structure shared among the team.

Extraneous Variables

Each instructor was assigned a comparison and treatment section. This helped minimize any data variance due to differences in instructor teaching styles and capabilities.

Instructor "A" used students' previous experience on teams as a decision-making point in team formation. Byrd and Luthy (2010) and Hunsaker et al. (2011) both reported that students who create team charters are likely to continue to use team charters in future teams. Hence, prior team (school/class work and extracurricular activity) and team charter-related experience data were collected. Participants completed three multiple-choice questions: (a) "How many times have you participated in a class related team assignment at school?"; (b) "How many times have you participated in an extra-curricular (not class related) team?"; (c) How many times have you created or used a team charter or contract?" These questions were labeled as *PTschool*—prior team school/class work related; *PTextracurricular*—prior team extracurricular; and *PTcharter*—prior team charter experience. Each question was answered using the multiple-choice options of: (a) 0 times; (b) 1–3 times; (c) 4–6 times; (d) 7–9 times; and (e) 10+ times.

Procedures

A total of four data collection points (T1 through T4) were used in collecting data from the study participants (two treatment and two comparison groups).

Treatment Section

Time one (T1)

The study was introduced during the first day of the third week of the semester—T1 (see Figure **3.1**). The third week was selected to: (a) provide instructors with time to assign teams; (b) allow teams to complete interdependent work via two team "mini" assignments; and (c) allow teams to receive their first long-term team-based assignment (the project deliverable was due approximately half-way in the semester). The decision to wait until teams had completed interdependent work was made based on prior personal experience with engineering teams' openness to receiving team-based instruction in light of pressing technical work. The first "mini" assignment required teams to complete an in-class analysis of a consumer product and post their report on the teams' assigned website. Teams had to study the question, "whether our reliance on technology is sustainable?", and prepare an eight-minute slide presentation to report their findings as their second

"mini" assignment.

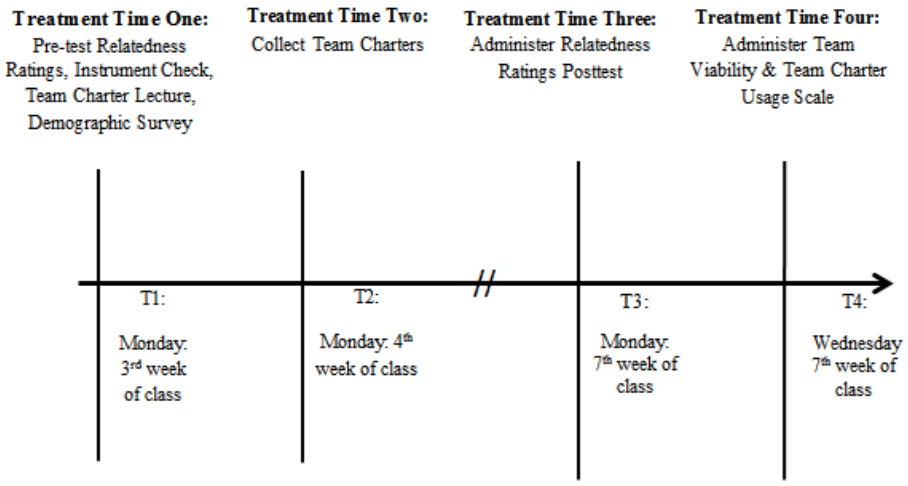

Figure 3.1. Treatment section timeline

The study was introduced to the class by the principal investigator; participants received the implied consent handout (see Appendix C) during the first five minutes. Next, participants took 20 minutes to complete the similarity relatedness pre-test (Appendix A). After all participants had turned in their pre-test, each person completed an instrument check (see Appendix D). Next, the team charter lesson was presented (see Appendix E) along with the subsequent assignment (45 minutes). Participants then completed the demographic survey in approximately 10 minutes (see Appendix F). Once the demographic survey was collected, participants were allowed to meet with their team members to begin the team charter homework assignment during the last 10 minutes. The total time for T1 was 90 minutes.

The team charter lesson (see Appendix E) was based on prior teaching experience at a small public southern university with team charters in freshmen STEM classes and extant team charter literature (e.g., Aranda et al., 1998; Cox & Bobrowski, 2000; Hunsaker et al., 2011). The lesson consisted of four team charter components: (a) *individual background*; (b) *mission statement and team goals*; (c) *roles and processes;* and (d) *performance agreement*.

Each team was responsible for drafting a team charter based on the discussion and homework assignment guidelines. Teams were tasked with completing, submitting, and posting a copy of their team charter to the team charter drop box via the electronic course management server. All team charters had to be posted to the drop box prior to the beginning of the next class meeting time. The charter was to be developed collaboratively. All members were to agree on the final document. The assignment was verbally given to the teams. No tangible study-related materials were distributed; this was done to avoid suppressing the teams' ability to create their own team charter without undue external input. Students were asked to keep the topic of the assignment and any related work confidential to avoid contamination with the comparison group. Teams had one week to complete the task. Charters were collected during the next week class—time two (T2).

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Instrument Check Items for Relatedness Ratings Listwise Survey

The instrument check for relatedness ratings listwise survey was evaluated using an objective measure. Objective measures were collected via a survey (see Appendix D).

A sample question from the survey was: "The exercise I just completed was about ratings terms that were: (a) related, or (b) not related." The measures were examined for accuracy. One point was awarded for each correct answer.

Time Two (T2)

T2 occurred during the second class meeting of the third week of the semester. Teams submitted their complete team charters by posting a copy to the drop box via the electronic course management server, and handed in a signed paper copy to their instructor at the beginning of class. Team charters were collected by the principal investigator. Next, each charter was evaluated for quality based on the Team Charter Rubric (see Appendix B) by two evaluators. Quality scores for each team charter were entered into an Excel spreadsheet for later data analysis. Instructors were not informed of the team charter quality scores.

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Time Three (T3)

Participants completed teamwork mental models measures using listwise relatedness ratings (e.g., Clariana & Wallace, 2009) posttest. Fifteen ratings (posttest), via relatedness comparisons, were matched by asking participants to select the two most related terms from Column II to the term in Column I (see Appendix A). Paper-and-pencil was used for the ratings measurement. Ratings were collected at the beginning of the class session just prior to student presentations for the first project (T3), the

approximate half-way point of the semester. The total time for the relatedness ratings data collection was 20 minutes.

Time Four (T4)

Students completed a team viability scale and other questions related to team charter use (see Appendix G) during the next scheduled class session (Wednesday of the 7th week) after the first team project presentations were finished. The team viability scale was based on a combination of work/scales by Jehn et al. (2008) and Tekleab et al. (2009). The timing was important because teams had not yet received a grade or feedback on their first major project assignment; hence, members were more likely to provide unbiased feedback. Additionally, the second project required members to remain in their current teams. Participants indicated a desire to complete their current work and perform future team-related tasks together—team viability has been shown to be a predictor of team effectiveness (Sundstrom et al., 1990). Surveys were completed in class as (opposed to email distribution) to decrease opportunities for participants to compare answers or experiences.

A timeline combining the treatment and comparison sections is presented in Figure 3.2.

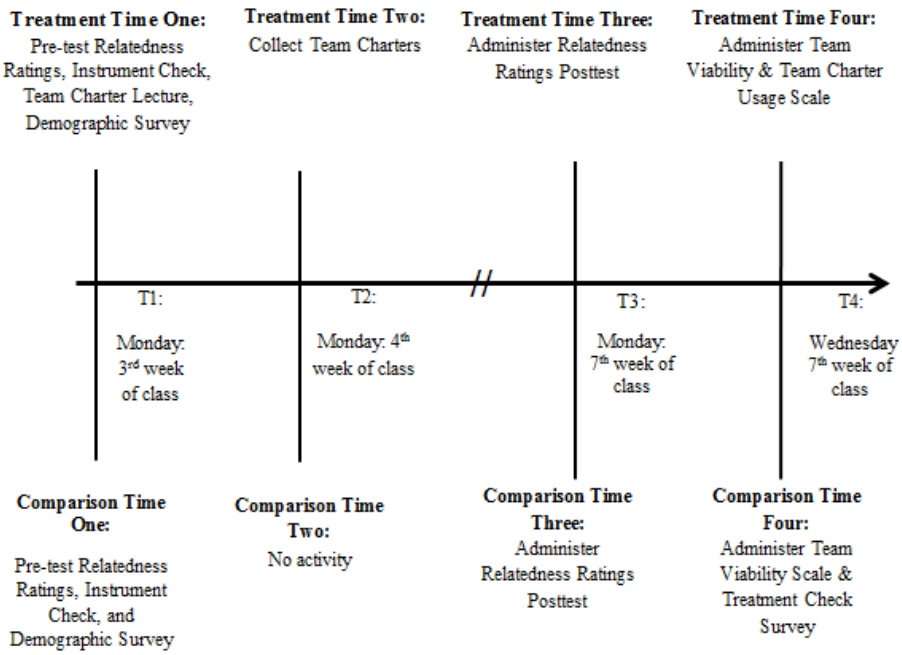

Figure 3.2**.** Treatment and comparison timeline combined

Comparison Section

All procedures for the comparison section of teams were the same as the treatment section, except the comparison teams did not receive team charter instruction and assignment (T2). Participants only completed the relatedness ratings pre and posttest, instrument check, demographic survey, and team viability scale (see Figure 3.2). A treatment check question was added to the comparison team viability scale: "Did you and your team discuss and write a plan to accomplish the project work?"

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In sum, study participants were a non-randomized sample of four groups: three treatment and two comparison (n = 38 teams) of EDSGN100 students. The treatment groups received team charter instruction and subsequent assignment. The comparison groups did not receive team charter instruction and no follow-up assignment was given. All participants self-reported on a demographic, pre and posttest relatedness ratings, instrument check, and team viability survey.

Pilot Study

A pilot study of the treatment procedures was completed in four sections of EDSGN 100. Each section consisted of six teams; on average, there were four participants per team (n = 24). The purpose of the pilot study was to test the data collection process and instruments. Efforts were made to follow each step of the proposed treatment procedures; with the exception of the time intervals between each data collection point (T1 through T4). The pilot study was administered during the eight-week summer session. The initial study was designed to fit the 15-week semester schedule. Hence, data collection times were much closer together, and teams did not have the normal length of time to execute their design project.

Changes Made to the Main Study

Based on feedback collected via the team charter usage survey (T4), the most helpful sections of the team charter related to accessibility (a) contact information, and

(b) availability/meeting time and (c) role designation (see Table 3.2). Thirty-seven percent of participants listed the creation of a team logo and team name, and discussion of individual member project-related strengths and weaknesses, as the least helpful sections of the team charter (see Table 3.3). Given engineering students' are often viewed as "output-focused" and not particularly attracted to teamwork (Li et al., 2009) creating a team name and logo was removed from the main study. Creating a team name and logo was removed from the main study. However, the decision was made to keep the discussion of team member project-related strengths and weaknesses in the lesson and subsequent assignment. This was done because team members typically discuss their strengths and weaknesses when assigning roles; roles was the second highest rated most helpful section of the team charter. To avoid redundancy in the participants' perception of team charter topics, specific discussion of meeting times, consequences (separate from the performance management section), planning schedules, and allocation of work were combined into other sections of the team charter lecture and rubric. Lastly, revisions were made to the relatedness ratings list.

In addition, changes were made to the listwise terms to reflect the changes made in the team charter lesson plan. Conflict management, consistent actions, purpose, team identity, and work allocation were removed from the study. The five additional terms were: (a) mission statement, (b) strengths, (c) team calendar, (d) weaknesses, and (e) strengths. The final list contained 15 terms.

Table 3.2

Frequency and Percent Total of Participant Responses to Most Helpful Section of the Team Charter

Terms	Frequency	Percent
Contact Information	22	22.68
Roles	15	15.46
Availability/Meeting Times	13	13.40
Strengths/Weaknesses	7	7.22
Work Allocation	6	6.19
Goals	5	5.15
Rules/Team Norms	4	4.12
Organization	3	3.09
Logo/Team Name	2	2.06
Conflict Management	2	2.06
Communication	2	2.06
Total	81	83.51
Missing	5	5.15
Total	97	100.00

Table 3.3

Frequency and Percent Total of Participant Responses to Least Helpful Section of the Team Charter

Terms	Frequency	Percent
Team Logo/Team Name	18	18.56
Individual Background/Strengths &Weaknesses	16	16.49
Roles	9	9.28
Meeting Times	6	6.19
Consequences	4	4.12
Planning Schedules	3	3.09
Allocation of Work	2	2.06
Mission Statement	2	2.06
Total	60	61.86
Missing	9	9.28
Total	97	100.00

Validation of Data Collection Instruments

Instrument Check

The objective measure instrument survey items were assessed for accuracy. The three questions were: (a) The exercise I just completed was about ratings terms that were; (b) In the exercise I just completed I selected how many terms from Column II that were most related to the term in Column I; and (c) How do you understand (define) the term "related" as it was used in the exercise you just completed? One point was given for each correct answer (see Tables 3.4, 3.5, and 3.6). Questions one and three produced 96.9% and 97.9% accuracy, respectively. Although question two was only 81.3% accurate, the question was retained since of the 96 surveys examined, only one participant did not select two ratings from column II for column I; that participant assigned two ratings from column II to column I in 15 of the 16 relatedness ratings listwise pairing. No changes were made to the instrument check.

Table 3.4

Frequency and Percent of Total Pilot Study Instrument Check Responses Question One: The task was about terms that were: related or unrelated?

Response	Frequency	Percent	Valid Percent	Cumulative Percent
Correct	93	96.9	96.9	96.9
Incorrect	1	1	1	97.9
No response	2	2.1	2.1	100
Total	96	100	100	

Table 3.5

Frequency and Percent of Total Pilot Study Instrument Check Responses Question Two: How many terms selected from Column II?

Response	Frequency	Percent	Valid Percent	Cumulative Percent
Correct	78	81.3	81.3	81.3
Incorrect	16	16.7	16.7	97.9
No response	2	2.1	2.1	100
Total	96	100	100	

Table 3.6

Frequency and Percent of Total Pilot Study Instrument Check Responses Question Three: How do you define related?

Response	Frequency	Percent	Valid Percent	Cumulative Percent
Correct	94	97.9	97.9	97.9
No response	2	2.1	2.1	100
Total	96	100	100	

Team Viability Scale

Individual team member viability scores were coalesced into a team viability score. According to LeBreton and Senter (2008) and James (1982), intraclass correlation coefficients (ICCs) are used to justify aggregating lower-level individual data into higher-level variables. A one-way ANOVA of ICC(1)—the reliability of the mean rating assigned by a group of raters (LeBreton & Senter, 2008) was calculated. As stated by LeBreton and Senter and Bliese (2000), ICC(1) should be interpreted as a measure of effect size. The ICC(1) of the pilot study was .21—a large effect size (pv) as stated in

Murphy, Myors, and Wolach (2009, p. 39). An ICC(1) of .34 translates to a 34% desire to want to work together again as a team, which can be explained by team membership.

According to Cronbach's alpha—internal consistency reliability—for the team viability scale was $\alpha = .88$.

Team Charter Usage Survey

More than half (51.5%) of the pilot study participants stated that they had not referred back to their team charter. Thirty-four percent had never mentioned the team charter once the assignment was submitted. Given the large percentage of team charter implementation failure—defined as teams not using the team charter—additional questions were added to better understand the reasons for the failures. Workload-sharing questions from Campion, Medsker, and Higgs (1993) were reviewed; however, it was decided that the questions did not provide the appropriate context for the current study. An additional question was added to the survey: "Did your team use ideas, processes, and/or information from your team charter during your design project? If not, why not?"

Analysis

Research Hypothesis

Research questions were addressed by testing the mediation—total, direct, and indirect effect of *quality* on *viability* through *similarity* (percent overlap). Ordinary least squares regression was used to test that the regression coefficient did not equal zero. The

null hypothesis was rejected at the .05 significance level. Partial mediation occurs when the effect of the dependent variable (*viability*) on the independent variable (*quality*) has been significantly reduced after entering the mediating variable (*similarity*). A statistical test for significance was conducted using the Preacher and Hayes (2004) macro to test for indirect effect and statistical significance.

Mediation

Mediation was examined in accordance with the testing method developed by Baron and Kenny (1986). First, the relationship of significance was tested between the independent variable—*quality*, and the dependent variable—*viability* (total effect labeled as path c in Figure 3.3). Next, a test to see if *quality*—independent variable, and *similarity*—mediator, were related (labeled as path a in Figure 3.4). The third step was to test for a relationship between the mediator—*similarity*, and the dependent variable—*viability* (labeled as path b in Figure 3.4). Step three was completed as an estimate by controlling for the effect of *quality* on *viability* (Frazier, Tix, & Barron, 2004). Lastly, the strength of the relationship between *quality* and *viability* was examined again after controlling for the effects of *similarity* (direct effect labeled path c' in Figure 3.4). The expectation was that the strength of the relationship between *quality* and *viability* would be significantly reduced if *similarity* was a partial mediator.

Research Question 1

What is the relationship between *quality* and *viability* in engineering student teams?

A total effect model (see Figure 3.3) was used to depict the relationship between *quality* (X) as the independent variable and *viability* (Y) as the dependent variable.

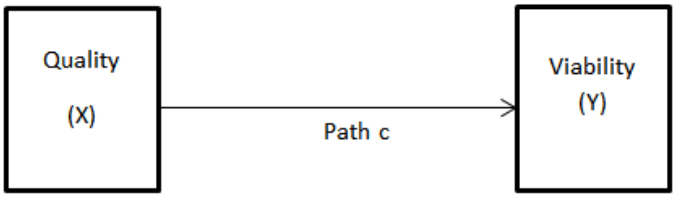

Figure 3.3. Visual depiction of total effect of *quality* on *viability*

Research Question 2

What is the relationship among *quality*, *similarity*, and *viability* in engineering student teams?

A simple mediation model (see Figure 3.4) was used to depict the nature of the relationship. The independent variable (X) was *quality*. *Similarity* (M) served as the partial mediator. *Viability* (Y) was the dependent variable.

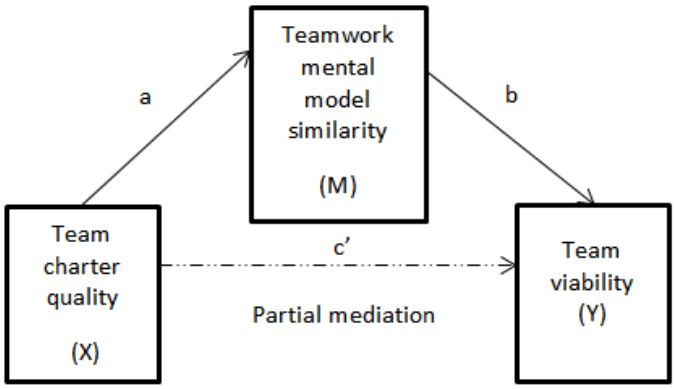

Figure 3.4. Visual depiction of indirect effect (partial mediation) of *quality* through *similarity* on *viability*

Participants in the current study were assigned to treatment or comparison group based on the section of EDSGN 100 in which they were enrolled—intact groups. Hence, a non-equivalent groups pre/posttest research design was used. This quasi-experimental method burdens the researcher with a critical internal threat to validity—selection differences (Reichardt & Mark, 2001), defined as "biases resulting from differential recruitment of comparison groups, producing different mean levels on the measure of effects" (Campbell, 1969, p. 3).

The current study examined effects of *quality* on *viability* through the *similarity* relationship. This examination provided a plausible and consistent plan and explanation for how and why team charters could be used in engineering design team-based classes.

Chapter 4

Findings

The purpose of the study was to test team charter creation as an instructional antecedent of team viability by comparing teams creating team charters with teams not creating team charters in engineering design team-based classes. Specifically, the study analyzed the relationship between team charter quality and team viability by giving one group team charter instruction and having them create a team charter, while the second group did not receive team charter instruction and were not informed about team charter creation. Second, teamwork mental model similarity was examined as a partial mediator of team charter quality on the team viability relationship. To this end, two research questions were examined: a) What is the relationship between *quality* and *viability* in engineering student teams?; and b) What is the relationship among *quality*, *similarity*, and *viability* in engineering student teams?

Participants

Five sections of EDGSN 100 participated in the main study. Three sections consisted of eight teams, and two sections were made up of seven teams (n = 38). Two instructors taught the five sections—instructor one taught two sections, and instructor two taught three sections. Twenty five teams were treatment groups; thirteen teams were comparison groups. Each instructor had a minimum of one comparison and one treatment group. There were 153 participants; however, 11 students had not reached their 18th

birthday, hence, their results are not included in the study. The final participant count was 142.

The ages of participants ranged from 18 years old to 28 years of age. The majority of participants (66.2%) were 18 years old, followed by 19 years old (22.3%). Twenty year olds accounted for 7.9% of the study participants. Five individuals were between 21 and 28 years of age. Seventy-nine percent were male and 19.7% were female.

Caucasians represented the largest racial group at 75.5%. The remaining distribution was as follows: (a) African/African-American, 1.4%, (b) Arab/Middle Eastern, 2.9%, (c) Asian/Asian American, 14.4%, and (d) Native Hawaiian/Pacific Islander, 5.8%.

Seventy two percent of the study participants were first-semester students. The majority (21.6%) of the remaining 28% had completed at least two semesters of course work. Mechanical engineering was the most represented major at 30.2%, followed by chemical engineering (15.8%), aerospace engineering(9.4%), and electrical engineering (9.4%). Approximately 17.2% were undecided engineering majors. Other majors included: (a) agricultural systems management, (b) bioengineering, (c) biomedical, (d) civil, (e) industrial, (f) mechanical and nuclear, and (g) nuclear.

As referenced in Table 4.1, approximately half of the individuals had participated in ten or more prior school-related team experiences—defined as working with another person to complete a task, project, or assignment for which all were responsible for the outcome. The response was slightly lower for participation in ten or more prior extra-curricular team experiences at 45.3%. Fewer than 1% of respondents had had ten or more team charter experiences.

Table 4.1

Number of Prior Team Experiences Reported by Participants

Number of Experiences	School Related		Extra-Curricular Related		Team Charter Creation	
	Actual	%	Actual	%	Actual	%
0	4	2.9	8	5.8	87	62.6
1 – 3	16	11.5	28	20.1	38	27.3
4 - 6	26	18.7	24	17.3	12	8.6
7 – 9	18	12.9	16	11.5	1	0.7
10 or more	75	54.0	63	45.3	1	0.7
Total	139	100	139	100	139	100

Note: For first semester participants prior team experiences were designated as high school teams. Individuals that completed one or more semesters of college were asked to reflect on prior college team experiences.

Nonequivalent Group Design

The pretest (similarity rating) mean and median were calculated for treatment and comparison groups to examine potential selection bias within the study. Treatment groups' pretest similarity ratings mean was .195 with a median of .170, compared to .192 and .180, respectively, for the comparison groups. There was homogeneity among the variances, as assessed by Levene's test for equality of variances (p = .408). Comparison groups' mean pretest similarity score was 0.003 (SE = 0.02) higher than the treatment mean similarity score. There was no statistically significant difference in the mean pretest similarity score between comparison and treatment groups, $t(36) = -.101$, $p = .920$.

Results

Team charter quality score data were separated into three components: a) no quality score (zero; absence of team charter—comparison teams); b) low-quality charter scores (29 through 71; 29 was the lowest earned score in the data set); and c) high-quality charter scores (72 and higher). The number of teams in each quality group was relatively equal. Fifteen teams had a zero quality score—all were part of the comparison group. High quality and low quality had 12 and 11 teams in each group, respectively.

What is the Relationship between Quality and Viability in Engineering Student Teams?

An independent-samples t-test was run to determine whether differences existed in team *viability* among those teams that received a team charter lecture and subsequent assignment and teams that had not received the lecture and assignment. The data set did not violate independent t-test assumptions (with the exception of case #23 as an outlier; the decision was made to keep the outlier in the data set). Team *viability* was greater in teams that received the lecture and completed the assignment (M = 5.73, SD = 0.66) than teams that did not receive the lecture and assignment (M = 5.04, SD = 0.93), a statistically significant difference of M = 0.69, 95% CI [.17, 1.21], $t(36) = 2.686$, p = .011, d = .88.

Next, a multiple regression analysis was run to examine the form, direction, and magnitude of the relationship between *team viability* and high- and low-*quality* team charter scores. Assumptions of linearity, independence of errors, homoscedasticity, unusual points and normality of residuals were met. High-quality team charter scores

statistically significantly predicted *team viability* (see Table 4.2); the null hypothesis was rejected at the p = .05. Low *quality* scores were not a significant predictor of *team viability*; the null hypothesis failed to be rejected. Overall, the team charter *quality* score accounted for 24.9% of the explained variability in team *viability*. In sum, the relationship between *quality* and *viability* was: a) not equal to zero; b) positive; and c) accounted for 1.049 for high-*quality* and .303 for low-*quality* unit change in team *viability* for every one unit increase in team charter *quality* scores.

Table 4.2

High and Low Team Charter Quality Scores Regressed onto Team Viability.

	Low	High	Viability
	Correlations		
Independent			
Low Quality	1.00		
High Quality	-.434**	1.00	
Dependent			
Viability	-.090	.517**	1.00
Mean (SD)	.289 (.459)	.315 (.471)	5.489 (.839)
b (SE)	.303 (.289)	1.049 (.282)**	5.040 (.188)
Unstandardized regression coefficient (constant)	5.040		
95% CI of b	[-.283, .889]	[.477, 1.621]**	[4.659, 5.421]

*Note: n = 38. ** p < .05, Adj. R^2= .249, df = 2, 35. CI = confidence interval.*

What is the Relationship among Quality, Similarity, and Viability?

Using a simple mediation analysis of ordinary least squares, no evidence was found to support an indirect influence of team charter *quality* score on team *viability* through its effect on teamwork mental model *similarity*. Based on 95% confidence levels

only one of the four regression models was not equal to zero—the high-*quality* charter score on *viability*. A one-unit increase in the team charter *quality* score produced a 1.049 increase in team *viability* and was statistically significant at the p > .05 level. All other tested relationships could equal zero; hence, the mediation null hypothesis failed to be rejected.

Summary of Research Hypotheses

Research questions were addressed by completing an independent t-test comparing treatment versus comparison teams. Additionally, ordinary least squares regression models were run, including total, direct, and indirect effect of *quality* on *viability* through *similarity* (percent overlap) to test that the regression coefficient did not equal zero. The null hypothesis was rejected at the .05 significance level. A statistical test for significance was conducted using the Hayes (2013) PROCESS macro to test for total, direct, and indirect effects and statistical significance via bias corrected bootstrap confidence intervals of 1,000 samples.

Research Question 1

A large effect size (*d = .88)* was determined between the mean comparison of teams receiving the team charter lecture and assignment, and teams that did not receive the lecture and assignment.

A positive relationship between team charter *quality* and team *viability* was established when charter scores were 72 and above. Low-*quality* charters, scores of 71 and below, failed to produce a predictive regression equation that did not include zero.

Research Question 2

The relationship among *quality*, *similarity*, and *viability* evidenced a positive, non-zero relationship only between high-*quality* charter scores and *viability*. The remaining regression equations—a) *quality* on *similarity*; b) *similarity* on *viability*; and c) partial mediation of *quality* on *viability* through *similarity*—failed to generate a non-zero relationship.

In sum, comparison teams did not participate in a team charter lecture; they also did not complete a team charter. These teams demonstrated lower viability than their treatment counterparts. However, team charter quality produced mixed results on team viability. Lower-quality team charters had a weak or no relationship with viability; a moderately positive and statistically significant relationship was demonstrated by higher-quality team charters.

Findings from the current study add to the team charter empirical record. Taking time at the beginning of a project to develop a quality plan for team functioning can be a predictor of higher levels of team effectiveness, and specifically of the desire for and ability of teams to work together again in the future.

Chapter 5

Discussion and Recommendations

Summary of the Research

According to the Accreditation Board for Engineering and Technology (ABET), engineering education institutions must produce graduates who can effectively work in a team environment (Accreditation Board for Engineering and Technology, n.d.). This is particularly important given that the public perception of students that aspire to become engineers are typically viewed as not interested in teamwork and solving social problems, but only good in "math and science are interested in making things" (Li et al., 2009, p. 371). Higher education institutions have implemented team-based assignments, courses, and a variety of team-building activities to meet the ABET accreditation standards, including team charters. And while team charters are being actively used in engineering education, no empirical studies have been conducted of the benefits or detriments of their use in the engineering classroom. Educators, particularly in the engineering discipline, require this and related information in order to fully understand the benefits and/or consequences of using this and other instructional activities in the classroom.

In this study, a non-equivalent group research design was used to test team charter implementation in a team-based engineering course at a land-grant university in the mid-Atlantic region. Participants were from five undergraduate sections of an introduction to engineering design course. A total of 38 teams (23 treatment and 15 comparison)

participated in the study. Treatment teams participated in a team charter lecture and created team charters as a homework assignment. Comparison teams did not participate in a team effectiveness/team charter lecture and did not complete a team charter.

Ordinary least square regression models were completed using team charter creation and quality as independent variables. Teamwork mental model similarity and team viability were investigated as mediator and dependent variables, respectively. Two research questions were examined: a) What is the relationship between *quality* and *viability* in engineering student teams, and b) What is the relationship among *quality*, *similarity*, and *viability* in engineering student teams?

Discussion and Implications of Findings

Research Question 1

The first research question was designed to determine whether a relationship existed between team charter creation and team viability in engineering student design teams. The current study demonstrated a positive relationship between team charter creation and team viability. Teams that participated in the team charter lecture and completed the subsequent assignment reported statistically significant higher levels of team viability than the comparison teams. The current study's findings support those from McDowell and colleagues (2011), who reported statistically significant findings between comparison group members and the team charter example only, and the team charter with instruction and additional instructional support for group members,

respectively. Additionally, the findings, from the current study, addressed a call by Bell and Marentette (2011) for research on relevant antecedents of team viability.

Team charter creation helps team members create a structured social network. The team charter process aids in forming relationship structures to attain a common goal. Also, with the establishment of roles and responsibilities team charters set up processes by which instrumental networks can be created. Social networks, expressive (friendship) and instrumental (advice), do matter for teams and have been shown to have a positive relationship with team viability (Balkundi & Harrison, 2006). Lastly, findings from the current study further support claims by Cox and Bobrowski (2000) and Hunsaker et al. (2011) that team charter enactment helps to minimize common student team pain points such as social loafing, poor communication, and unresolved conflict.

A second point of discussion from the first research question is the importance of the quality of the team charters. Teams with high-quality team charters reported higher levels of team viability. Findings from the current study lend support to the Mathieu and Rapp (2009) study—spending time early in the team lifecycle to develop high-quality charters promotes positive team outcomes. A key component of a well-written team charter is communication processes. High-quality team charters typically include components that foster open communication, such as contact information-sharing, preferred methods of communication, availability and preferred work times, and a team calendar. The inclusions of these key components help members to create a feeling of open communication by discussing norms and preferences, and documenting the conversation. Second, teams that produce high-quality team charters often share appropriate aspects of individual members' backgrounds, such that members feel more

confident about the diverse nature of the team in accomplishing the goal and continuing to work as a productive unit in the future. Team inputs, such as open communication and educational diversity, have been positively related to building team viability (Foo, Sin, & Yiong, 2006).

An implication from the current study is that student teams benefit from dedicated team effectiveness instruction and a subsequent project-related assignment—both act to positively affect team viability, which is one form of team effectiveness. Including the team charter lecture and assignment in the project lesson sets the expectation that members must dedicate time to plan for team success. Engineering design educators who decide to use teams as an instructional component in their class should include a team charter lesson, have teams create a charter, and assess the quality of said charters. In doing so, students will understand and act on the importance of pre-project planning.

Research Question 2

The second research question was designed to examine whether teamwork mental model *similarity* was a partial mediator between team charter *quality* and team *viability.* It was hoped that findings would both explain and address gaps in the team charter literature on the reasons for the effects/lack of effects of team charter enactment on team outcomes. However, no mediational relationship was evidenced from the current study. Based on meta-analytic findings from DeChurch and Mesmer-Magnus (2010a) and knowledge structure measurement work from Clariana and Wallace (2009) and Clariana (2010a), it was expected that teamwork mental model *similarity* would, at a minimum,

evidence a positive relationship with team charter *quality* and team *viability*, and that it would lead to partial mediation. *Team charter enactment* and *quality* both failed to produce stable relationships with teamwork mental model *similarity*. Recommendations and future research are presented on next steps needed to more thoroughly understand findings related to the second research question.

Recommendations and Future Research

Team charter creation demonstrated a positive relationship with team viability. However, further research is needed to understand why. While teamwork mental models have explained what sets high-performing teams apart from their lower-performing peers, no such evidence was found in the current study. Possible explanations and future improvements to measuring teamwork mental model could help determine whether there is indeed a mediational relationship among team charter *quality*, *similarity*, and *viability*. Three areas from the current study could be refined: a) increased restrictions on the elicitation exercise, b) setting the appropriate level of contextual perception for participants, and c) fully implementing the team charter into the course, rendering it more than a one-time event about which participants later forget.

Restrictions on Elicitation Exercise

As stated by DeChurch and Mesmer-Magnus (2010a), “care should be taken to design and implement measures of mental models that capture not only the content but

also the structure of the mental model" (p. 10). The relatedness rating exercise in the current study was designed based on the recommendations of DeChurch and Mesmer-Magnus. Components of mental model measurement include: elicitation, structure representation, and representation of emergence (Mohammed et al., 2000). The efficacy of mental model measurement is dependent on having all three components appropriately represented. Of the three components in the elicitation process, participant adherence to the relatedness instructions appears to have the greatest opportunity for discussion and improvement.

Pairwise relatedness ratings are a commonly used elicitation technique. However, pairwise is a long and arduous process. Recent findings have demonstrated that the multi-decision approach (listwise and sorting combined) is an adequate substitute for pairwise comparisons (Clariana, 2010b). The current study took place in an actual classroom—for that reason, the listwise technique was refined to reduce perceived classroom intrusion and potential participant fatigue. A double listwise process was created with the guidance of a faculty member very familiar with knowledge structure measurement.

Participants were presented with a paper copy of the relatedness exercise. Fifteen terms, all related to the team charter lecture and assignment, were listed in the identical order in column I and column II (see Appendix A). Each student was asked to select the two terms from column II that were most related to the terms in column I. Specifically, participants were asked, verbally and via written instructions, to only use each term twice. However, based on examining the relatedness ratings of the first person (to complete the exercise) from each team (n = 38) only 37% of the team members actually followed the instructions. Participants were able to use the terms more than twice because

the exercise was administered via pencil/pen and paper. The decision was made to use pencil/pen and paper to make sure data collection could be completed regardless of the availability of technology in the engineering design labs and classrooms. Some classrooms did not have computers. There was no guarantee that computers would be in a room being used on each data collection date. A future adaptation of this exercise should be completed via an online method, thereby limiting participants to the use of each term no more than two times.

Contextual Perception

A second recommendation to further refine the current study involves emphasizing the elicitation contextual perception of study participants. As stated by Clariana (2010b), "context likely influences what is actually captured during an elicitation task, the context that is set by the elicitation task probably matters a great deal in the structure of knowledge that is obtained" (p. 46). Clariana further explained that contextual perception can increase or inhibit the activation of the state of some "ensembles (e.g. concepts, terms)" (p. 46). The use of stories or narratives contained within the elicitation tool can help maintain a common level of contextual perception. The story/narrative technique was not utilized in the current study. A basic script (see Appendix A) was read to participants. However, due to scheduling changes a shortened script and condensed timetable were needed for the last data collection. Also, the regular course instructor was not present during the last session. Future renditions of the current

study could include a written narrative as the introduction, along with the verbal script, in the relatedness ratings elicitation document.

Team Charter Implementation

A possible third recommendation is to improve the team charter implementation rate; a total of 59.7 % (see Table 5.1) of treatment participants stated that they used ideas, processes, and/or information from the team charter. Of that 59.7%, 35% only used the contact information from the team charter. Therefore, just 25% of participants used process-related data from the team charter. Nonuse of the charter could have negatively affected their ability to relate the terms, even after completing and submitting the assignment. This explanation is supported by Urch Druskat and Pescosollido (2002), who stated that not having a clear understanding of the team charter could increase dissimilarity among shared mental models and detrimentally affecting team effectiveness. Team members may not have had enough interaction with the team charter to form an increased similarity—overlap of relatedness terms. Hunsaker et al. (2011) also found that team charters failed to influence team member behavior because members did not revisit or consult the team charter after it was created. As seen in Tables 5.2 and 5.3, participants demonstrated a low level of commitment to team charter use. Future studies should include mechanisms to trigger a higher participant commitment rate for team charter use.

Table 5.1

Frequency and Percent of Total Treatment Participants' Responses to "Did the Team Use Ideas, Processes and/or Information from the Team Charter?" (n = 83)

Response	Frequency	Percent	Valid Percent	Cumulative Percent
No	31	37.3	40.3	40.3
Yes	46	55.4	59.7	100.0
Total	77	92.8	100.0	
Missing	NR	6	7.2	
Total		83	100.0	

Table 5.2

Frequency and Percent of Total Treatment Participants' Responses to Number of Times They Referred Back to the Team Charter (n = 83)

# of Times	Frequency	Percent	Valid Percent	Cumulative Percent
No response	3	3.6	3.6	3.6
0 times	35	42.2	42.2	45.8
1-3 times	39	47.0	47.0	92.8
4-6 times	5	6.0	6.0	98.8
7-9 times	1	1.2	1.2	100.0
Total	83	100.0	100.0	

Table 5.3

Frequency and Percent of Total Treatment Participants' Responses to Number of Times Team Charter was Mentioned During Project Cycle (n = 83)

# of Times	Frequency	Percent	Valid Percent	Cumulative Percent
No response	3	3.6	3.6	3.6
0 times	37	44.6	44.6	48.2
1-3 times	37	44.6	44.6	92.8
4-6 times	3	3.6	3.6	96.4
7-9 times	2	2.4	2.4	98.8
10+ times	1	1.2	1.2	100.0
Total	83	100.0	100.0	

One such process is to have the course instructor and teaching/lab assistants receive copies of each team charter, participate in the grading of the charters, and encourage participants/teams to rely on their team charter throughout the project and/or course.

Limitations

Three potential limitations may have influenced this study: a) research design; b) dependent variable aggregation; and c) the inus condition.

The current study was designed for intact teams in a pre-existing engineering course; hence, random assignment of teams was not possible. To address this sampling strategy limitation a research invitation was sent to all course instructors. Three instructors expressed interest; however, only two were selected. The third instructor taught an honors section of the course. The content, pace, and requirements for the honors course did not align with those of the non-honors sections. The remaining two participating instructors were both assigned a comparison and a treatment. The assignments were counter-balanced to account for time of day (i.e., morning and afternoon). Future research should make every effort to use a randomized sampling strategy; this is mostly likely to occur in a lab-based experiment.

A second issue of the nonequivalent research design is the lack of support for causal inference. Although the research design used in the current study is depicted as a traditional path diagram—X➔Y, AND X➔M➔ Y, representing hypotheses about possible causal influence—we can only test whether the hypothesized causal model is

consistent or inconsistent with a particular causal model. Future iterations of this study should take precautions to implement the basic experimental research design.

In addition, team assignment biases were minimized via each instructor using either a survey or "count off" method. The instructor for comparison section "A" and treatment section "A" assigned teams based on results from a student preference/experience class survey; family relationships; and surface-level diversity. Sample survey questions included the following: "Hands-on building experience: (a) not sure, (b) minimal, (c) fair, (d) good, (e) excellent"; open-ended questions included: "Describe your experience of working in teams (academic, sports, other)". Siblings were assigned to different teams. Actions were taken to distribute various components of surface-level diversity—observable or known differences such as race, gender, or educational background. Instructor "B" assigned teams by having students count off one through eight. Each number represented a team; students were assigned to their team based on the order of the numbers.

The dependent variable—team *viability*—score was aggregated from individual team member viability scores. A second potential limitation is justifying aggregation in a multilevel analysis. An ICC(1) was computed (.21), resulting in a medium to large effect size (i.e., percentage of variance explained; Murphy et al. [2009]). Although a medium effect size was evidenced, future research should investigate possible error in the team viability scale to increase confidence in aggregating individual team member data to a team-level viability score.

Lastly, one must consider high-quality team charters as an "inus condition" (Mackie, 1965), defined as a unique condition or set of conditions that by itself cannot

solely cause a specific outcome, like an increase in team viability scores. While it is sufficient when combined with optimal other conditions, it is not necessary to trigger the outcome. As such future research must investigate the co-conditions of planning—high quality team charters that enable higher reported levels of team effectiveness (*viability*).

Recommendations for Engineering Educators

The current study provided evidence supporting team charter enactment—lecture participation and subsequent assignment, and high-quality team charters—as plausible instructional antecedents of team effectiveness, operationalized as viability. Three recommendations for engineering education are presented: consistency, qualitative inquiry, and in-class reflection.

A specific recommendation for the course used in the current study is to institute consistency in the team effectiveness component of the curriculum. On average 25 sections, taught by 18 instructors, are offered each fall and spring semester. The department provides specific learning guidelines and foci for the technical components of the course. However, instructors are often left on their own to figure out how to best prepare students to be effective in the team projects. Ironically, teamwork skill-building is listed as a central theme on the webpages for the course, instructor, and department. Each section should set team effectiveness competence as one of its minimum standards. Teaching the student to successfully maneuver the technical content in the midst of a team assignment is not the same as ensuring that engineering graduates are equipped to be world-class engineers or meet the ABET accreditation standards. Team effectiveness

competence could include three stages of the team life cycle: planning—team charter enactment (including lecture, homework assignment, quality scoring); execution of the project—project management tools and interim team process statuses; and evaluation—team debriefing. These additions would bring consistency to the EDSGN 100 curriculum across sections and instructors, as well as communicate “how” and “why” team charters should be used in engineering student team courses.

Second, the current study solely focused on team charter enactment and quality as a precursor to team viability. Future studies could advance the present findings by adding qualitative research components. For example, interviews could be hosted with teams at the end of project one and before they begin project two. Questions could address level of charter quality, team charter use, and ways to improve intrateam charter implementation.

An area of strength within the current EDSGN 100 course is its use of project management tools such as Gantt charts and interim project task-related reports; however, no such structure is in place to encourage and expect student teams to gauge their intrateam teamwork processes. A third area for future consideration is team reflection or debriefing, also termed blameless autopsy by Collins (2001). Teams should have dedicated time within the course to reflect on what went well and not well during their project. This effort could be beneficial for teams that are to remain together as well as for teams that are disbanding and reforming into new teams. Most importantly, implementing a dedicated time of project reflection could be combined with revisiting their team charter to make necessary intrateam process improvements. Prospective studies could build on Marks et al.'s (2001) work on temporally based frameworks and taxonomies by inducing forced mid- and end-points for team process reflection. Future research should investigate

which instructional antecedents are likely to help teams be more effective once the project has already begun (e.g., timely structured team feedback sessions).

The current study was conducted to address the need for greater knowledge of team effectiveness antecedents within the engineering classroom. Although outside the scope of this research, the professional development of engineering education instructors is a vital component in the engineering student team effectiveness equation. Team charter enactment, as implemented in the current study, can easily be presented at instructor seminars, both face-to-face and institutionalized via online learning.

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Appendix A

Relatedness Ratings (Pre and Posttest)

Write the number of the *two terms* from Column II that are most related to the term in Column I.

For example someone could think Mississippi and Tennessee are more related to Arkansas than are Maryland and Pennsylvania. However, someone else may think Maryland, Mississippi, and Pennsylvania are more related.

You cannot match a term to itself. You many only use each term two times.

Example

Column I	Rating 1	Rating 2	Column II
Arkansas			1 Arkansas
			2 Pennsylvania
			3 Mississippi
			4 Maryland
			5 Tennessee

Pre-test Starts Here

Column I	Rating 1	Rating 2	Column II
Tracking Work Progress			1. Tracking Work Progress
Signed			2. Signed
Team norms			3. Team norms
Team Goals			4. Team Goals
Team Calendar			5. Team Calendar
Leadership			6. Leadership
Roles			7. Roles
Personal background			8. Personal background
Meeting Management			9. Meeting Management
Consistent			10. Consistent
Dysfunctional Behaviors			11. Dysfunctional Behaviors
Decision Making			12. Decision Making
Contact information			13. Contact information
Team purpose			14. Team purpose
Availability			15. Availability

Appendix B

Team Charter Rubric

EDSGN Section: _____ Team Number: _____

Only enter information, a score of 0, 3, or 5, into the green boxes. **0** = The team did not address the question. **3** = The team partially addressed the question. **5** = The team fully addressed the question.
NOTE: **1d**, **3b**, and **6** are worth 10 points. **0** = The team did not address the question. **5** = The team partially addressed the question. **10** = The team fully addressed the question.

Total Score (out of 90 points):

1) Individual background (25 points; 5 points each; Team Calendar (1d) is worth 10 points)
a) Personal background and project related strengths and weaknesses
Is the personal background and project related strengths and weaknesses identified for each member of the team?
b) Contact information and preferred medium(s) (Text, e-mail, etc.)
Is contact information for each member identified?
c) Availability and preferred work times
Is availability identified for each member?
d) Team calendar
Was a complete team calendar (name, primary contact number, preferred email address and team availability) provided?

2) Mission Statement and Team Goals (10 points; 5 points each)
a) Team purpose (mission statement)
Did the team provide a mission statement?
b) Team goals.
Did the team provide goals?

3) Roles and Processes (30 points; 5 points each; Roles (3b) is worth 10 points)
a) Leadership
Was a TL identified? Did team provide justification for selecting or not selecting a TL? TL expectations identified?
b) Roles
Were roles, other than that of Leader, identified?

c) Decision making process identified.

Was a decision making process included: most vocal wins, voting, consensus (100% agree)?

d) Meeting Management

Are meeting management processes identified? Does it include meeting action items and written follow-up?

e) Tracking Work Progress

Progress monitoring process identified?

4) Performance Agreement (10 points; 5 points each)

a) Adhering to Team Norms

Process to deal with non-adherence to team norms identified?

b) Dysfunctional Behaviors

Process to deal with dysfunctional team behaviors identified?

5) Entire Team Signatures (5 points)

Did all members of the team sign the charter?

6) Consistency (10 points)

Do the sub-components of the team charter align with the overall charter?

Appendix C

Implied Consent Handout

Implied Informed Consent Form for Social Science Research
The Pennsylvania State University

Title of Research Effectiveness of Engineering Student Teams

Principal Investigator:
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1. **Purpose of the Study:** The purpose of this study is to examine team effectiveness in engineering design teams.

2. **Procedures to be followed:** You will be asked to answer a series of questions regarding team experiences.

3. **Duration/Time:** The study is expected to take approximately 150 minutes (divided into multiple time periods).

4. **Statement of Confidentiality:** Your participation in this research is confidential. In the event of any publication or presentation resulting from the research, no personally identifiable information will be shared because your name is in no way linked to your responses.

5. **Right to Ask Questions:** Please contact Veronica Conway Hughston at vcc1@psu.edu with questions or concerns about this study

6. **Payment for Participation:** One team will win a $50 gift card. Only teams with full study participation will qualify.

7. **Voluntary Participation:** Your decision to be in this research is voluntary. You can stop at any time. You do not have to answer any questions you do not want to answer.

You must be 18 years of age or older to take part in this research study.
Completion and return of the survey implies that you have read the information in this form and consent to take part in the research.

Appendix D

Objective Instrument Check

On the scale provided below, please answer the questions **based on the exercise you just completed.**

1. The exercise I just completed was about rating terms that were:
    a. Related
    b. Not related
2. In the exercise I just completed **I selected how many terms from Column II** that were most related to the term in Column I (circle only one answer).
    a. 1
    b. 2
    c. 3
    d. 4
3. How do you understand (define) the term **"related"** as it was used in the exercise you just completed?
    a. Connected
    b. Similar
    c. Associated
    d. Separate

Appendix E

Team Charter Lesson Plan

TEAM CHARTER PRESENTATION
Has anyone ever heard of a team charter? *Wait for a show of hands* Quite simply a *team charter is an agreed upon plan of how you are going to work as a team*.

I will apologize now; I will ask you very few questions during the lesson. This is done to keep the content of the lesson the same for each class I teach. You get to listen and take really good notes b/c you and your team will have to complete your own team charter.

Most team charters consist of four main categories: *Individual background; Mission statement and goals; Roles and processes;* and *Performance management.*

Team charters have been well studied as critical factors in successful team performance. You and the members of your team will be tasked with creating a team charter for your design project for this class. A printed copy of the charter will be due next Monday. It is expected that all members of your team work on the charter collaboratively (all working on all parts, synthesizing the individual knowledge into the whole). I encourage you to take good notes during this presentation.

The charters will be evaluated for comprehensiveness and consistency as a part of my research study. Your team charter quality score will NOT influence your class grade. However, you will receive up to 5 points towards your final grade for completing all the study related instruments.

The first category of a well written team charter is the ***Individual Background*** section. This section consists of four sub categories: ***personal background of each member, contact information for each member, availability and preferred work times of each member, and team calendar.***

1. ***Individual background***
    a. Understanding the individual background of each member of your team is important for two reasons: a) you know the project related strengths of each member; and b) you know the project related skill weaknesses of each member of the team. Knowing this information helps members of the team allocate work based on skill set.
    b. Collecting fellow team members contact information and preferred methods of each team member at the beginning of the project will save you time by having the information before you need it.
        i. It is important to not only give the information, but to identify your preferred method of contact. For example, I prefer email or text message because I don't check voicemail.

   ii. You should be very specific to give the actual email address and or appropriate phone number to the team. This seems like a no brainer; however, many people have multiple email accounts. Not to mention multiple social networking accounts. So, be specific.

c. The last sub category in the ***individual background section*** is ***availability and preferred work times***. Often times you do not share the same exact class, extracurricular, and study schedules as your fellow team members. So you should be very specific about when you are available to meet with your team and your preferred work times. Specific, but still flexible.
d. A very easy section of the team charter is the ***team calendar***. It is your go to guide for team communication and scheduling. Members usually share the following information on their team calendar: names, phone number preferred email address for each member, and availability.
   i. A great example of why you should create a team calendar is: let's say the four of us (point to three people) are on a team together. We take the same classes; however, I just joined an extreme golf Frisbee team. The golf Frisbee team gets together on Mondays and Thursdays night after dinner. Hence, by joining the team I have reduced the number of available hours I am able to meet with my team. Oh, and to complicate things even more I go to bed by 9 because I am a super early riser. I get up at 5am to work out.
   ii. A way to minimize the negative issues (such as frustration w/me when the team wants to meet at 9pm every night to work on the project) is to create a team calendar.
      1. Each member puts their work time preferences, outside class commitments, exams, quizzes, family events (weddings) etc. on the calendar so the team can have a visual of available team time to meet and work on team related "stuff".
      2. The team calendar can change and should be reviewed as needed during the project. Google docs is a good tool for the team calendar.
      3. You should attach your team calendar to your team charter pdf file.

The second category of an effective team charter is the **mission statement and *team goals***.

1. The importance of a ***mission statement/purpose*** is it sets the direction of the team. Most times the mission statement of a project team in the classroom environment is set by the guidelines of the assignment. So you do not have to draft a mission statement. However, you should list the mission statement as the purpose from the project in your team charter AND create team goals to help you have a successful project experience.

2. Goals are the action steps to help you accomplish the ***mission statement***. Goals are normally SMART. S-specific, M-measurable, A-actionable, R-realistic, and T-time bound.
    a. ***Team Goals*** may change. As you work in your teams, you may find you can shorten some ***goals***. Or you may find you have to re-visit some ***goals*** because of various setbacks in your project work.
3. These are the categories that make a high quality ***mission statement and team goals*** section of the team charter. These two sections should be a part of your team charter.

The third major category of a high quality team charter is ***Roles and Processes***. This is the largest section of the team charter. The first sub category is ***roles***.

1. It is vital that ***roles*** are assigned at the beginning of your team life cycle. Imagine playing a team sport like baseball. If there were no roles assigned, then how would players know what position to play? It would be mass chaos. The same is true for a project team.
    a. One of the first ***roles*** to be decided is that of the team leader. Now, here is something important: you do not have to have a leader! So there are two options: assign a leader or do not assign a leader. A high quality team charter contains details about the role of team leadership.
        i. It typically consists of the Who and Why…who is the leader and why did the team choose that person. It is not a complicated item to include: Barb was selected as leader b/c she was President of her high school science team. Or Bob was selected b/c he asked to be the leader.
        ii. If no leader was chosen. Then a high quality team charter typically entails why a leader was not selected, and how leadership decisions will be made.
        iii. The ***role*** of leader can also rotate. Again, the who and why is typically discussed. If you choose to rotate leadership roles in your team you should identify when roles when be changed (i.e. the leader role will change every two weeks).
    b. Assignment of ***roles*** in a high quality team charter is often reviewed multiple times during the project.

The next three sub categories will require you and your team to discuss and answer the following questions:

3. **Decision making** is how will you make decisions: most vocal wins, voting, consensus (100% agree)?
4. **Meeting management:** How will you handle meeting action items and written follow-up?
5. **Tracking work progress:** How will you keep track of milestones and status checks within the team and with external stakeholders (this becomes increasingly important during your next project)?

Remember the goal is to plan to succeed; no plan reduced the likelihood of success.

The last major category of a high quality team charter is ***Performance Agreement***. This category can be a team's best weapon against slackers **who knows what I mean by the word slacker…just raise your hands** and poor performers. I warn you the conversation around ***performance agreement*** can be tense at times; however, if every member of the team approaches the topic as a "preparedness" task then it tends to go smoothly. So let's be honest if you ever worked on a team there is a high probability that everyone didn't do their fair share. Or someone tends to miss almost all of the meetings but wants the same great grade you received. **Does this sound familiar…just shake your head** The ***performance agreement*** section can help your team know what to do when issues like lateness, or poor performance rears its ugly head. So I encourage you, do not skip this section in your team charter homework assignment.

1. The first step in a high quality ***performance agreement*** section of the team charter is to develop good behaviors on using your team charter. If the team demonstrates good discipline to using the charter, then the members will more likely exemplify the positive team norms and behaviors in the team charter. So, you will have to ask yourself "How will we ensure our actions throughout the duration of the project are consistent with our team charter?"
2. Secondly, you will want to determine and include in your team charter "How will we deal with members not adhering to team charter?"
    a. An example let's say in the team charter we as a team agreed that we would meet each Sunday night to work on the project; however, each Sunday night I send a note stating I can't meet. What will you do?
3. Lastly, a high quality team charter details "How the team will deal with dysfunctional behaviors, e.g., missing or being late to a meeting, dominating, withdrawing, wasting time, etc.?" Will you bring in the instructor for every grievance? Again, this section should be in your team charter.
    a. For example if I am always late to the meetings. How will your team address the issue…ignore my rude behaviors and hope I start showing up on time? Negative behaviors such as lateness only grow worse with time. And in fact the negative behaviors are sometimes contagious…other members may feel like since Veronica is never on time, then I won't be on time either.
    b. Or more commonly you have one team member that is always on time, never misses a meeting, BUT never says much or anything at the meetings. Do you allow that person to be a good attender, but never contribute to the project?
    c. This may sound hard, but it is not. Simply think about what makes a meeting effective: people do their assigned tasks, bring the stuff they said they would, turn cell phones to vibrate or silent, no texting or mobile device distractions (pinterest pinning or tweeting).

A high quality team charter is signed by all members and consistent

Let's review the ***four major categories of a high quality team charter: individual background; mission statement and team goal; roles and behaviors; and lastly performance management***. As I said the assignment may sound like a lot; however, most of the sub categories are 1-2 sentences in the team charter. You simply have to state what you are going to do to be prepared as a team to plan to be successful and proactively address the issues.

Remember a high quality team charter consists of 15 sub-categories and is consistent meaning what you write in one section supports other sections that are related to it.

TEAM CHARTER ASSIGNMENT

- Your assignment is to write a team charter based on the presentation in class today. The charter must be agreed upon by all team members. All members must sign the final document. The work is to be done collaboratively; do not split up the assignment. You have until the next Monday (INSERT DATE) to craft and post in the class drop box on Angel. PDF FILES ONLY. Bring one finalized, signed, copy (per team) with you to the next scheduled class period. The charter will be assessed for comprehensiveness and consistency.
- Ask if anyone has questions.
    - If yes, answer the question quickly and succinctly. Ask the instructor to write down the question(s) so that you can refer back to the list for review of study modifications.
    - If no, announce teams can get 10 minutes today to work on their team charter assignment.

Appendix F

Demographic Survey

Team experiences are defined as the numbers of times you have worked with another person to complete a task, project, or assignment that you were all responsible for the outcome. *Select one rating for each question e.g. a, b, c, d,* or *e.*

1. How many times have you participated in a class related team assignment at school?
    a. 0 times
    b. 1-3 times
    c. 4-6 times
    d. 7-9 times
    e. 10+ times
2. How many times have you participated in an extra-curricular (not class related) team?
    a. 0 times
    b. 1-3 times
    c. 4-6 times
    d. 7-9 times
    e. 10+ times
3. How many times have you created or used a team charter or contract?
    a. 0 times
    b. 1-3 times
    c. 4-6 times
    d. 7-9 times
    e. 10+ times
4. What is your race/ethnicity (Circle only one answer)?
    a. African American/Black
    b. American Indian/Alaskan Native
    c. Asian/Asian American
    d. Caucasian/White
    e. Hispanic/Latino
    f. Native Hawaiian/Pacific Islander
5. What is your sex/gender (Circle only one answer)*:*
    g. Female
    h. Male
6. How old are you? (e.g., 18): _____ years old

7. How many semesters have you completed at Penn State (not including the current semester)? _

8. What is your major (e.g., Mechanical Engineering, undecided, etc.)? _____

Appendix G

Team Viability Scale and Team Charter Use Survey—Treatment Sections

1. To what extent would you like to participate in another task with the same team members?

Extremely Unlikely	Unlikely	Somewhat Unlikely	Neutral	Somewhat Likely	Likely	Extremely Likely
1	2	3	4	5	6	7

2. I would be happy to work with the team members on other projects in the future.

Strongly Disagree	Disagree	Somewhat Disagree	Neither Agree or Disagree	Somewhat Agree	Agree	Strongly Agree
1	2	3	4	5	6	7

PLEASE NOTE THE CHANGE IN ORDER OF THE RATINGS

3. If you could have left this team and worked with another team, would you have?

Strongly Agree	Agree	Somewhat Agree	Neither Agree or Disagree	Somewhat Disagree	Disagree	Strongly Disagree
1	2	3	4	5	6	7

4. This team should not have continued to function as a team.

Strongly Agree	Agree	Somewhat Agree	Neither Agree or Disagree	Somewhat Disagree	Disagree	Strongly Disagree
1	2	3	4	5	6	7

5. This team probably should never work together in the future.

Strongly Agree	Agree	Somewhat Agree	Neither Agree or Disagree	Somewhat Disagree	Disagree	Strongly Disagree
1	2	3	4	5	6	7

6. If I had the chance, I would have switched teams.

Strongly Agree	Agree	Somewhat Agree	Neither Agree or Disagree	Somewhat Disagree	Disagree	Strongly Disagree
1	2	3	4	5	6	7

To what extent do you agree with the following statements?

	Strongly Disagree	Disagree	Somewhat Disagree	Neither Agree or Disagree	Somewhat Agree	Agree	Strongly Agree
1. We relied heavily upon our team charter to complete the project.	1	2	3	4	5	6	7
2. We revised our team charter during the project.	1	2	3	4	5	6	7
3. We found the team charter assignment helpful to the success of how my team performed.	1	2	3	4	5	6	7
4. I will use team charters in my future teamwork.	1	2	3	4	5	6	7
5. Team charters should be used in every team based class.	1	2	3	4	5	6	7

PLEASE NOTE THE CHANGE IN ORDER OF THE RATINGS

6. The team charter was not helpful to the success of how my team performed.	7	6	5	4	3	2	1

7. What was the most helpful part of your team charter?

_____

8. What was the least helpful part of your team charter?

_____

9. How often did you refer back to your team charter during team interactions?
   a. 0 times
   b. 1-3 times
   c. 4-6 times
   d. 7-9 times
   e. 10+ times

10. How often was "team charter" mentioned your team discussions?
   a. 0 times
   b. 1-3 times
   c. 4-6 times
   d. 7-9 times
   e. 10+ times

11. Did your team use ideas, processes, and/or information from your team charter during your design project?
   Yes or No (circle one)
   If not, why not?

_____

_____

_____

Appendix H

Team Viability Scale and Treatment Question—Comparison Sections

1. To what extent would you like to participate in another task with the same team members?

Extremely Unlikely	Unlikely	Somewhat Unlikely	Neutral	Somewhat Likely	Likely	Extremely Likely
1	2	3	4	5	6	7

2. I would be happy to work with the team members on other projects in the future.

Strongly Disagree	Disagree	Somewhat Disagree	Neither Agree or Disagree	Somewhat Agree	Agree	Strongly Agree
1	2	3	4	5	6	7

PLEASE NOTE THE CHANGE IN ORDER OF THE RATINGS

3. If you could have left this team and worked with another team, would you have?

Strongly Agree	Agree	Somewhat Agree	Neither Agree or Disagree	Somewhat Disagree	Disagree	Strongly Disagree
1	2	3	4	5	6	7

4. This team should not have continued to function as a team.

Strongly Agree	Agree	Somewhat Agree	Neither Agree or Disagree	Somewhat Disagree	Disagree	Strongly Disagree
1	2	3	4	5	6	7

5. This team probably should never work together in the future.

Strongly Agree	Agree	Somewhat Agree	Neither Agree or Disagree	Somewhat Disagree	Disagree	Strongly Disagree
1	2	3	4	5	6	7

6. If I had the chance, I would have switched teams.

Strongly Agree	Agree	Somewhat Agree	Neither Agree or Disagree	Somewhat Disagree	Disagree	Strongly Disagree
1	2	3	4	5	6	7

7. Did you and your team discuss and write a plan to accomplish the project work? **Yes or No** (only circle one)

Appendix I

Data Collection Procedures

Treatment T1: Pre-test, Instrument Check, Team Charter Lesson, and Demographic Survey Procedures

BEFORE THE STUDENTS ARRIVE

1. Meet with instructor to unlock the classroom door.
2. Ask the instructor does he have any questions prior to the students arriving.
    a. If yes, answer them and write down the question(s) so that you can refer back to the list for review of study modifications.
    b. If no, thank the instructor again for allowing you to participate and collect data.
3. Ensure tables and chairs are set up facing the front of the room.
4. Set up laptop, connect to the project, open presentation file, and test to make sure everything is in working order.
5. Put the projector in sleep mode until you begin the study.
6. Put a pile of pencils, 35 copies of the Demographic Survey and one manila folder marked "Demo Survey", 35 copies of the Relatedness Rating Pre-test and one manila folder marked "Pre-test" at the front table, and 35 copies of Subjective Instrument Check (all copies should be face down on the table).

CLASS START TIME

1. Stand in the back of the classroom while the instructor starts the class and introduces the researcher.
2. Walk to the front of the class, thank the instructor, and begin the slide presentation.
3. Introduce yourself as a Penn State researcher, read the Implied Consent form to the class. SLIDE 1. Ask if there are any questions related to the material just read to the class.
    a. If there are questions, answer them quickly and succinctly. Ask the instructor to write down the question(s) so that you can refer back to the list for review of study modifications.
    b. If there are no questions.
4. Announce that per the Implied Consent slide participation in the study is voluntary.
5. Advance to the next slide SLIDE 2. Tell the class you need their opinion on how things are related. But, first let's figure out and practice what I mean by "related". Read the directions to the class:

6. Write the number of the *two terms* from Column II that are most related to the term in Column I. Announce to them we are looking for their opinion as to what terms are related.

Example 1

Column I	Rating 1	Rating 2	Column II
Arkansas			1 Arkansas
			2 Pennsylvania
			3 Mississippi
			4 Maryland
			5 Tennessee

7. Hit the enter button to advance the slide SLIDE 4. Say: For example someone could think Mississippi and Tennessee are more related to Arkansas. You cannot match a term to itself.

Example 2

Column I	Rating 1	Rating 2	Column II
Arkansas	3	5	1 Arkansas
			2 Pennsylvania
			3 Mississippi
			4 Maryland
			5 Tennessee

8. Hit the enter button to advance the slide SLIDE 5. Say: However, someone else may think Arkansas, Maryland, and Mississippi are more related. You cannot match a term to itself.

Example 3

Column I	Rating 1	Rating 2	Column II
Arkansas	4	3	1 Arkansas
			2 Pennsylvania
			3 Mississippi
			4 Maryland
			5 Tennessee

9. Ask if there are any questions.
   a. If yes, answer the question quickly and succinctly. Ask the instructor to write down the question(s) so that you can refer back to the list for review of study modifications.
   b. If there are no questions, tell the participants they may complete the form. Remind them we are looking for their opinion as to what terms are related.

PRETEST

1. Handout the Relatedness Rating form (Pretest) SLIDE 6.

2. Record the start time on the front of the manila envelope marked “pretest”.
3. Quietly walked around the room to observe how the participants are progressing. If you notice some of them seem to be spending too much time trying to figure out the “right” answer or looking stressed or unsure announce again: “we are looking for your opinion as to what terms are related.”
4. Keep track of time. At the 10 minute mark ask “how many people need more time?” Acknowledge and state you will check back in with them in 5 minutes.
5. At the 15 minute mark ask again “how many people need more time?” Acknowledge and state you will check back in with them in 5 minutes.”
6. If no one needs more time at the 15 minute mark, collect all the sheets. If participants still need more time, announce they have five more minutes to complete the form.
7. At the 20 minute mark ask if anyone else needs more time. If yes, encourage them to wrap up by giving their opinion of terms that are related.
8. Record the stop time of the last participant on the front of the manila folder marked “pretest”.

SUBJECTIVE INSTRUMENT CHECK

1. Then advance the next slide SLIDE 7 to the Subjective Instrument Check. Tell participants they have a few minutes to complete the three question survey.
2. Hand out the Subjective Instrument Check. Collect completed sheets, put into the manila folder marked “Subjective Instrument Check”.
3. Thank the students and tell them to take a quick 2 minute stretch break.
4. While participants are on the two minute break advance the slide to the “stretch break” slide SLIDE 8.

TEAM CHARTER PRESENTATION

SLIDE 9

Has anyone ever heard of a team charter? *Wait for a show of hands* Quite simply a *team charter is an agreed upon plan of how you are going to work as a team*.

I will apologize now; I will ask you very few questions during the lesson. This is done to keep the content of the lesson the same for each class I teach. You get to listen and take really good notes b/c you and your team will have to complete your own team charter.

Most team charters consist of four main categories: *Individual background; Mission statement and goals; Role, and processes;* and *Performance management.* SLIDE 10

Team charters have been well studied as critical factors in successful team performance. You and the members of your team will be tasked with creating a team charter for your design project for this class. A printed copy of the charter will be due next Monday. It is expected that all members of your team work on the charter collaboratively (all working on all parts, synthesizing the individual knowledge into the whole). I encourage you to take good notes during this presentation.

The charters will be evaluated for comprehensiveness and consistency as a part of my research study. Your team charter quality score will NOT influence your class grade. However, you will receive up to 5 points towards your final grade for completing all the study related instruments.

SLIDE 11

The first category of a well written team charter is the ***Individual Background*** section. This section consists of three sub categories: ***personal background of each member, contact information for each member; and availability and preferred work times of each member.***

2. ***Individual background***
    a. Understanding the individual background of each member of your team is important for two reasons: a) you know the project related strengths of each member; and b) you know the project related skill weaknesses of each member of the team. Knowing this information helps members of the team allocate work based on skill set.
    b. Collecting fellow team members contact information and preferred methods of each team member at the beginning of the project will save you time by having the information before you need it.
        i. It is important to not only give the information, but to identify your preferred method of contact. For example, I prefer email or text message because I don't check voicemail.
        ii. You should be very specific to give the actual email address and or appropriate phone number to the team. This seems like a no brainer; however, many people have multiple email accounts. Not to mention multiple social networking accounts. So, be specific.
    c. The last sub category in the ***individual background section*** is ***availability and preferred work times***. Often times you do not share the same exact class, extracurricular, and study schedules as your fellow team members. So you should be very specific about when you are available to meet with your team and your preferred work times. Specific, but still flexible.
3. A very easy section of the team charter is the ***team calendar***. It is your go to guide for team communication and scheduling. Members usually share the following information on their team roster: names, phone number preferred email address for each member, and availability.
    a. A great example of why you should create a team calendar is: let's say the five of us (point to four people) are on a team together. We take the same classes; however, I just joined an extreme golf Frisbee team. The golf Frisbee team gets together on Mondays and Thursdays night after dinner. Hence, by joining the team I have reduced the number of available hours I am able to meet with my team. Oh, and to complicate things even more I go to bed by 9 because I am a super early riser. I get up at 5am to work out.

   b. A way to minimize the negative issues (such as frustration w/me when the team wants to meet at 9pm every night to work on the project) is to create a team calendar.
      i. Each member puts their work time preferences, outside class commitments, exams, quizzes, family events (weddings) etc. on the calendar so the team can have a visual of available team time to meet and work on team related "stuff".
      ii. The team calendar can change and should be reviewed as needed during the project.

SLIDE 12

The second category of an effective team charter is the **mission statement and *team goals***.

4. The importance of a ***mission statement*** is it sets the direction of the team. Most times the mission statement of a project team in the classroom environment is set by the guidelines of the assignment. So you do not have to draft a mission statement. However, you should list the mission statement from the project in your team charter AND create team goals to help you have a successful project experience.
5. Goals are the action steps to help you accomplish the ***mission statement***. Goals are normally SMART. S-specific, M-measurable, A-actionable, R-realistic, and T-time bound.
   a. ***Goals*** may change. As you work in your teams, you may find you can shorten some ***goals***. Or you may find you have to re-visit some ***goals*** because of various setbacks in your project work.
   b. One of my ***goals*** that relates to me graduating is: was to complete all my classes by summer 2013. I have had to modify that ***goal*** b/c one of the classes I signed up for was cancelled due to low enrollment. Hence, my new goal is to complete all my classes by Fall 2013.
6. These are the categories that make a high quality ***mission statement and team goals*** section of the team charter.

SLIDE 14

The third major category of a high quality team charter is ***Roles, Expectations, and Processes***. This is the largest section of the team charter. The first sub category is ***roles***.

2. It is vital that ***roles*** are assigned at the beginning of your team life cycle. Imagine playing a team sport like baseball. If there were no roles assigned, then how would players know what position to play? It would be mass chaos. The same is true for a project team.
   a. One of the first ***roles*** to be decided is that of the team leader. Now, here is something important: you do not have to have a leader! So there are two options: assign a leader or do not assign a leader. A high quality team charter contains details about the role of team leadership.
      i. It typically consists of the Who and Why…who is the leader and why did the team choose that person. It is not a

complicated item to include: Barb was selected as leader b/c she was President of her high school science team. Or Bob was selected b/c he asked to be the leader.

ii. If no leader was chosen. Then a high quality team charter typically entails why a leader was not selected, and how leadership decisions will be made.

iii. The ***role*** of leader can also rotate. Again, the who and why is typically discussed. If you choose to rotate leadership roles in your team you should identify when roles when be changed (i.e. the leader role will change every two weeks). Don't forget to state why you choose two weeks.

b. Assignment of ***roles*** in a high quality team charter is often reviewed multiple times during the project.

The next six sub categories will require you and your team to discuss and answer the following questions:

6. Decision making is how will you make decisions: most vocal wins, voting, consensus (100% agree)?
7. How will you handle meeting action items and written follow-up?
8. How will you keep track of milestones and status checks within the team and with external stakeholders (this becomes increasingly important during your next project)?

Remember the goal is to plan to succeed; no plan less likelihood of success.

SLIDE 15

The last major category of a high quality team charter is ***Performance Agreement***. This category can be a team's best weapon against slackers **who knows what I mean by the word slacker…just raise your hands** and poor performers. I warn you the conversation around ***performance agreement*** can be tense at times; however, if every member of the team approaches the topic as a "preparedness" task then it tends to go smoothly. So let's be honest if you ever worked on a team there is a high probability that everyone didn't do their fair share. Or someone tends to miss almost all of the meetings but wants the same great grade you received. **Does this sound familiar…just shake your head** The ***performance agreement*** section can help your team know what to do when issues like lateness, or poor performance rears its ugly head. So I encourage you, do not skip this section in your team charter homework assignment.

4. The first step in a high quality ***performance agreement*** section of the team charter is to develop good behaviors on using your team charter. If the team demonstrates good discipline to using the charter, then the members will more likely exemplify the positive team norms and behaviors in the team charter. So, you will have to ask yourself "How will we ensure our actions throughout the duration of the project are consistent with our team charter?"
5. Secondly, you will want to determine "How will we deal with members not adhering to team charter?"

   b. An example let's say in the team charter we as a team agreed that we would meet each Sunday night to work on the project; however, each Sunday night I send a note stating I can't meet. What will you do?
6. Lastly, a high quality team charter details "How the team will deal with dysfunctional behaviors, e.g., missing or being late to a meeting, dominating, withdrawing, wasting time, etc.?" Will you bring in the instructor for every grievance?
   d. For example if I am always late to the meetings. How will your team address the issue…ignore my rude behaviors and hope I start showing up on time? Negative behaviors such as lateness only grow worse with time. And in fact the negative behaviors are sometimes contagious…other members may feel like since Veronica is never on time, then I won't be on time either.
   e. Or more commonly you have one team member that is always on time, never misses a meeting, BUT never says much or anything at the meetings. Do you allow that person to be a good attender, but never contribute to the project?
   f. This may sound hard, but it is not. Simply think about what makes a meeting effective: people do their assigned tasks, bring the stuff they said they would, turn cell phones to vibrate or silent, no texting or mobile device distractions (pinterest pinning or tweeting).

SLIDE 16
A high quality team charter is signed by all members and consistent

SLIDE 17
Let's review the ***four major categories of a high quality team charter: individual background; mission statement and team goal; roles, expectations and behaviors; and lastly performance management***. As I said the assignment may sound like a lot; however, most of the sub categories are 1-2 sentences in the team charter. You simply have to state what you are going to do to be prepared as a team to plan to be successful and proactively address the issues.

SLIDE 18
Remember a high quality team charter consists of 20 sub-categories and is consistent meaning what you write in one section supports other sections that are related to it.

TEAM CHARTER ASSIGNMENT
SLIDE 19

- Your assignment is to write a team charter based on the presentation in class today. The charter must be agreed upon by all team members. All members must sign the final document. The work is to be done collaboratively; do not split up the assignment. You have until the next class session (INSERT DATE) to craft and post your charter on your team's designated website, and post in the class drop box on Angel. Bring one finalized, signed, copy (per team) with you to the

next scheduled class period. The charter will be assessed for comprehensiveness and consistency.

- Ask if anyone has questions.
    - If yes, answer the question quickly and succinctly. Ask the instructor to write down the question(s) so that you can refer back to the list for review of study modifications.
    - If no, announce teams can get 10 minutes today to work on their team charter assignment.

DEMOGRAPHIC SURVEY
SLIDE 20

1. Advance the slide to the demographic survey. Hand out the Demographic Survey.
2. If someone chooses not to participate they can write their first and last name and "decline" to participate on their demographic survey.
3. Collect all demographic surveys. Put them in the manila folder marked "demo survey" on the front table.

IN CLASS WORK

1. Stay at the front of the class while the teams work on their charters. Announce you are there to answer questions if they have any.
2. Once the 10 minutes are up. Announce that you are leaving and remind participants the charter assignment is due at the next class meeting.
3. Close down the laptop and projector. Pack up all the study materials. Leave the room quietly as the instructor transitions the class back to the syllabus topic.

Treatment T2: Team Charter Assignment Collection Procedures

BEFORE PARTICIPANTS ARRIVE

1. Meet with instructor to unlock the classroom door.
2. Ask the instructor does he have any questions prior to the students arriving.
    a. If yes, answer them and write down the question(s) so that you can refer back to the list for review of study modifications.
    b. If no, thank the instructor again for allowing you to participate and collect data.

CLASS START TIME

1. Announce you are in class to collect the team charter homework assignment.
2. Collect all the team charters.
    a. Review each team charter for list of team member names.
    b. If a team charter is missing a list of members read aloud the first few sentences on the charter and ask whose assignment is it.

c. Have the members write their name on the back of the charter.
d. Once all charters are collected and a list of members are included with each charter thank the class and instructor.
e. Leave the class quietly so the instructor can transition the class back to the syllabus topic.

Treatment T3: Posttest Procedures

BEFORE PARTICIPANTS ARRIVE

1. Meet with instructor to unlock the classroom door.
2. Ask the instructor does he have any questions prior to the students arriving.
   a. If yes, answer them and write down the question(s) so that you can refer back to the list for review of study modifications.
   b. If no, thank the instructor again for allowing you to participate and collect data.

CLASS START TIME

1. Advance to slide SLIDE 1. Read the directions to the class:
2. Write the number of the *two terms* from Column II that are most related to the term in Column I. Announce to them we are looking for their opinion as to what terms are related.

Example of slide 1

Column I	Rating 1	Rating 2	Column II
Arkansas			1 Arkansas
			2 Pennsylvania
			3 Mississippi
			4 Maryland
			5 Tennessee

3. Hit the enter button to advance the slide SLIDE 2. Say: For example someone could think Mississippi and Tennessee are more related to Arkansas. You cannot match a term to itself.

Example of slide 2

Column I	Rating 1	Rating 2	Column II
Arkansas	3	5	1 Arkansas
			2 Pennsylvania
			3 Mississippi
			4 Maryland
			5 Tennessee

4. Hit the enter button to advance the slide SLIDE 3. Say: However, someone else may think Arkansas, Maryland, and Mississippi are more related. You cannot match a term to itself.

Example of slide 2

Column I	Rating 1	Rating 2	Column II	
Arkansas	4	3	1	Arkansas
			2	Pennsylvania
			3	Mississippi
			4	Maryland
			5	Tennessee

5. Ask if there are any questions.
   - If yes, answer the question quickly and succinctly. Ask the instructor to write down the question(s) so that you can refer back to the list for review of study modifications.
   - If there are no questions, tell the participants they may complete the form. Remind them we are looking for their opinion as to what terms are related.

POSTTEST

1. Handout the Relatedness Rating form (Posttest) SLIDE 4.
2. Record the start time on the front of the manila envelope marked "pretest".
3. Quietly walked around the room to observe how the participants are progressing. If you notice some of them seem to be spending too much time trying to figure out the "right" answer or looking stressed or unsure announce again: "we are looking for your opinion as to what terms are related."
4. Keep track of time. At the 10 minute mark ask "how many people need more time?" Acknowledge and state you will check back in with them in 5 minutes.
5. At the 15 minute mark ask again "how many people need more time?" Acknowledge and state you will check back in with them in 5 minutes."
6. If no one needs more time at the 15 minute mark, collect all the sheets. If participants still need more time, announce they have five more minutes to complete the form.
7. At the 20 minute mark ask if anyone else needs more time. If yes, encourage them to wrap up by giving their opinion of terms that are related.
8. Record the stop time of the last participant on the front of the manila folder marked "posttest".

SUBJECTIVE INSTRUMENT CHECK

1. Then advance the next slide SLIDE 5 to the Subjective Instrument Check. Tell participants they have a few minutes to complete the three question survey.
2. Hand out the Subjective Instrument Check. Collect completed sheets, put into the manila folder marked "Subjective Instrument Check".
3. Thank the students and tell them to take a quick 2 minute stretch break.

4. While participants are on the two minute break advance the slide to the "stretch break" slide SLIDE 6.

Treatment T4: Team Viability and Team Charter Use Procedures

BEFORE PARTICIPANTS ARRIVE

1. Meet with instructor to unlock the classroom door.
    a. Ask the instructor does he have any questions prior to the students arriving.
    b. If yes, answer them and write down the question(s) so that you can refer back to the list for review of study modifications.
    c. If no, thank the instructor again for allowing you to participate and collect data.
2. Place the Team Viability and Team Charter Use survey and one manila envelope marked "TV and TCU" at the front table.

CLASS START TIME

1. Announce you are in class to administer and collect the final study data.
2. Handout the Team Viability and Team Charter Use survey.
3. Mark the start time on the manila folder.
4. Track the time; at the five minute mark ask "who needs more time?" Acknowledge, and announce they will have five more minutes.
5. Track the time; at the ten minute mark ask "who needs more time? Acknowledge, and announce they will have a few more minutes.
6. Track the time; at the two minute mark ask "who needs more time?
7. Once all participants are done thank the class for participating in the study.
8. Collect all the surveys, pack study materials and exit the class quietly.

Comparison T1: Pre-test, Instrument Check, and Demographic Survey Procedures

BEFORE THE STUDENTS ARRIVE

1. Meet with instructor to unlock the classroom door.
2. Ask the instructor does he have any questions prior to the students arriving.
    a. If yes, answer them and write down the question(s) so that you can refer back to the list for review of study modifications.
    b. If no, thank the instructor again for allowing you to participate and collect data.
3. Ensure tables and chairs are set up facing the front of the room.

4. Set up laptop, connect to the project, open presentation file, and test to make sure everything is in working order.
5. Put the projector in sleep mode until you begin the study.
6. Put a pile of pencils, 35 copies of the Demographic Survey and one manila folder marked "Demo Survey", 35 copies of the Relatedness Rating Pre-test and one manila folder marked "Pre-test" at the front table, and 35 copies of Instrument Check (all copies should be face down on the table).

BEFORE PARTICIPANTS ARRIVE

1. Meet with instructor to unlock the classroom door.
2. Ask the instructor does he have any questions prior to the students arriving.
    a. If yes, answer them and write down the question(s) so that you can refer back to the list for review of study modifications.
    b. If no, thank the instructor again for allowing you to participate and collect data.

CLASS START TIME

1. Advance to slide SLIDE 1. Read the directions to the class:
2. Write the number of the *two terms* from Column II that are most related to the term in Column I. Announce to them we are looking for their opinion as to what terms are related.

Example of slide 1

Column I	Rating 1	Rating 2	Column II
Arkansas			1 Arkansas
			2 Pennsylvania
			3 Mississippi
			4 Maryland
			5 Tennessee

3. Hit the enter button to advance the slide SLIDE 2. Say: For example someone could think Mississippi and Tennessee are more related to Arkansas. You cannot match a term to itself.

Example of slide 2

Column I	Rating 1	Rating 2	Column II
Arkansas	3	5	1 Arkansas
			2 Pennsylvania
			3 Mississippi
			4 Maryland
			5 Tennessee

4. Hit the enter button to advance the slide SLIDE 3. Say: However, someone else may think Arkansas, Maryland, and Mississippi are more related. You cannot match a term to itself.

Example of slide 2

Column I	Rating 1	Rating 2	Column II	
Arkansas	4	3	1	Arkansas
			2	Pennsylvania
			3	Mississippi
			4	Maryland
			5	Tennessee

5. Ask if there are any questions.
    a. If yes, answer the question quickly and succinctly. Ask the instructor to write down the question(s) so that you can refer back to the list for review of study modifications.
    b. If there are no questions, tell the participants they may complete the form. Remind them we are looking for their opinion as to what terms are related.

PRETEST

1. Handout the Relatedness Rating form (Pretest) SLIDE 4.
2. Record the start time on the front of the manila envelope marked "pretest".
3. Quietly walked around the room to observe how the participants are progressing. If you notice some of them seem to be spending too much time trying to figure out the "right" answer or looking stressed or unsure announce again: "we are looking for your opinion as to what terms are related."
4. Keep track of time. At the 10 minute mark ask "how many people need more time?" Acknowledge and state you will check back in with them in 5 minutes.
5. At the 15 minute mark ask again "how many people need more time?" Acknowledge and state you will check back in with them in 5 minutes."
6. If no one needs more time at the 15 minute mark, collect all the sheets. If participants still need more time, announce they have five more minutes to complete the form.
7. At the 20 minute mark ask if anyone else needs more time. If yes, encourage them to wrap up by giving their opinion of terms that are related.
8. Record the stop time of the last participant on the front of the manila folder marked "pretest".

SUBJECTIVE INSTRUMENT CHECK

1. Then advance the next slide SLIDE 5 to the Subjective Instrument Check. Tell participants they have a few minutes to complete the three question survey.
2. Hand out the Subjective Instrument Check. Collect completed sheets, put into the manila folder marked "Subjective Instrument Check".

3. Thank the students and close down the laptop and projector. Pack up all the study materials. Leave the room quietly as the instructor transitions the class back to the syllabus topic.

Comparison T2: No Activity

Comparison T3: Posttest Procedures

BEFORE PARTICIPANTS ARRIVE

1. Meet with instructor to unlock the classroom door.
2. Ask the instructor does he have any questions prior to the students arriving.
    a. If yes, answer them and write down the question(s) so that you can refer back to the list for review of study modifications.
    b. If no, thank the instructor again for allowing you to participate and collect data.

CLASS START TIME

1. Advance to the next slide SLIDE 1. Read the directions to the class:
2. Write the number of the *two terms* from Column II that are most related to the term in Column I. Announce to them we are looking for their opinion as to what terms are related.

Example of slide 1

Column I	Rating 1	Rating 2	Column II
Arkansas			1 Arkansas
			2 Pennsylvania
			3 Mississippi
			4 Maryland
			5 Tennessee

3. Hit the enter button to advance the slide SLIDE 2. Say: For example someone could think Mississippi and Tennessee are more related to Arkansas. You cannot match a term to itself.

Example of slide 2

Column I	Rating 1	Rating 2	Column II
Arkansas	3	5	1 Arkansas
			2 Pennsylvania
			3 Mississippi
			4 Maryland
			5 Tennessee

4. Hit the enter button to advance the slide SLIDE 3. Say: However, someone else may think Arkansas, Maryland, and Mississippi are more related. You cannot match a term to itself.

Example of slide 2

Column I	Rating 1	Rating 2	Column II	
Arkansas	4	3	1	Arkansas
			2	Pennsylvania
			3	Mississippi
			4	Maryland
			5	Tennessee

5. Ask if there are any questions.
   a. If yes, answer the question quickly and succinctly. Ask the instructor to write down the question(s) so that you can refer back to the list for review of study modifications.
   b. If there are no questions, tell the participants they may complete the form. Remind them we are looking for their opinion as to what terms are related.

POSTTEST

1. Handout the Relatedness Rating form (Posttest) SLIDE 4.
2. Record the start time on the front of the manila envelope marked "posttest".
3. Quietly walked around the room to observe how the participants are progressing. If you notice some of them seem to be spending too much time trying to figure out the "right" answer or looking stressed or unsure announce again: "we are looking for your opinion as to what terms are related."
4. Keep track of time. At the 10 minute mark ask "how many people need more time?" Acknowledge and state you will check back in with them in 5 minutes.
5. At the 15 minute mark ask again "how many people need more time?" Acknowledge and state you will check back in with them in 5 minutes."
6. If no one needs more time at the 15 minute mark, collect all the sheets. If participants still need more time, announce they have five more minutes to complete the form.
7. At the 20 minute mark ask if anyone else needs more time. If yes, encourage them to wrap up by giving their opinion of terms that are related.
8. Record the stop time of the last participant on the front of the manila folder marked "posttest".

SUBJECTIVE INSTRUMENT CHECK

1. Then advance the next slide SLIDE 5 to the Subjective Instrument Check. Tell participants they have a few minutes to complete the three question survey.
2. Hand out the Subjective Instrument Check. Collect completed sheets, put into the manila folder marked "Subjective Instrument Check".

3. Thank the students and close down the laptop and projector. Pack up all the study materials. Leave the room quietly as the instructor transitions the class back to the syllabus topic.

Comparison T4: Team Viability and Treatment Check Question Procedures

BEFORE PARTICIPANTS ARRIVE

1. Meet with instructor to unlock the classroom door.
2. Ask the instructor does he have any questions prior to the students arriving.
3. If yes, answer them and write down the question(s) so that you can refer back to the list for review of study modifications.
4. If no, thank the instructor again for allowing you to participate and collect data.
5. Place 35 copies of the Team Viability and Team Charter Use survey and one manila envelope marked "TV and TCheck" at the front table.

CLASS START TIME

1. Announce you are in class to administer and collect the final study data.
2. Handout the Team Viability and Treatment Check survey.
3. Mark the start time on the manila folder.
4. Track the time; at the five minute mark ask "who needs more time?" Acknowledge, and announce they will have five more minutes.
5. Track the time; at the ten minute mark ask "who needs more time? Acknowledge, and announce they will have a few more minutes.
6. Track the time; at the two minute mark ask "who needs more time?
7. Once all participants are done thank the class for participating in the study.
8. Collect all the surveys, pack study materials and exit the class quietly.

VITA

Veronica Conway Hughston

Education

The Pennsylvania State University, University Park, PA

Ph.D., Workforce Education and Development (expected May 2014)

M. Ed., Workforce Education and Development (1997)

B. S., Agricultural Business Management (1994)

Professional Qualifications and Experiences

Outreach, The Pennsylvania State University, Graduate Assistant

- Strategy and Planning Analyst (current)
- Strategic Planning and Process Facilitator (Spring 2012–current)
- Training and Development Coordinator (Spring 2012)
- Alumni Program Coordinator (Fall 2011 and Spring 2012)

Regional Director of Operations, LensCrafters - Luxottica

District Sales Manager, The Children's Place

Target Corporation

- Store Team Leader
- Executive Team Leader

Human Resource Manager, Armstrong World Industries, Inc.

Education, Development, and Training Specialist, The Pennsylvania State University

Training Development Specialist, Pathmark Stores, Inc.

New Holland North America, Inc.

- Human Resources Associate/|Affirmative Action Officer
- Buyer Analyst

Papers and Publications

Kim, T. &Hughston, V. (2012). The diffusion of changes in organizations: Proposing an organization-specific diffusion model. Peer Reviewed Paper, Academy of Human Resource Development 2013 Conference

Refereed Work in Progress: Hughston, V. (in press). An empirical study: Team charters and viability in freshmen engineering design. The Frontiers in Education 2013 Annual Conference. Oklahoma City, Oklahoma: IEEE.