Affective Dispositions and Cognitive Skills in Critical Thinking: Implications for Measurement, Training, and Team Performance

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Affective Dispositions and Cognitive Skills in Critical Thinking: Implications for Measurement, Training, and Team Performance

by

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A thesis submitted in partial fulfillment of the requirements for the degree of
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ABSTRACT

This study attempts to increase critical thinking among teams by making them
cognizant of seven critical thinking dimensions. Forty three-person teams of
undergraduates worked together on a complex decision-making task. Each team received
training in and was asked to ensure their group exhibited the characteristics of cognitive
skills, affective dispositions, both of these or neither. Critical thinking was assessed using
self-report, behavioral observation rating, and expert outcome analysis. The findings
suggest training in affective dispositions increases the exhibition of at least one
dimensions of critical thinking. A behavioral measurement is presented and evaluated
with respect to established critical thinking methods.
The teaching techniques of Socrates, whereby probing questions are asked of students to lead them toward knowledge, are often cited as the first recorded instance of critical thinking (Fasko, 2003). Descartes subsequently helped move the study of the mind from the realm of theology to the realm of pre-science by suggesting thinking is the property of the mind, and as such it is endowed with certain innate knowledge (Schultz & Schultz, 1996). Two hundred years later, however, John Locke proposed the notion that the mind without experience was a tabula rasa, or blank slate. He believed ideas were a result of experience and complex ideas were simply many simple ideas joined together (Fasko, 2003). Regardless of with whom you agreed, it was clear the scientific study of thought had begun.

The nineteenth century saw rise to modern psychology and with it new ways of explaining thinking. Beginning with Wilhelm Wundt, and continuing with Edward Titchener, thinking was assessed and explored using introspection. Titchener proposed an elaborate structure of consciousness comprising three states: sensations, images, and affective states (Schultz & Schultz, 1996). John B. Watson later denied even the existence of a consciousness; he believed thinking was nothing more than sub-vocal speech (Fasko, 2003). With the very existence of thinking in question, it seemed a complete change in perspective was needed.

And so it seemed everything from physics to psychology was beginning to shift from the reductionistic introspection associated with Wundt and Titchener toward the more integrative school of gestalt. Led by Wertheimer, Kohler, and Koffka, the gestalt school viewed thinking as an active, constructive process. This active view of thought
was later influenced by the burgeoning interest in computer technology, and led naturally
to the information-processing model of thinking that was prevalent in the 1960s. This
model provides a functional, organized framework for understanding mental processes
using the processes of attention, encoding and retrieval, and is evocative of the model
used to understand the way computers processes information. In the early 1980s, the
information-processing model evolved into a more involved, more active thought
process—a framework ideally suited to the investigation of critical thinking (Fasko,
2003).

In part in response to the newly active, involved thought process models that were
being proposed during this time, many researchers became increasingly aware of the
automatic aspects of human thinking. In order to survive in an increasingly hostile world,
humans have developed the ability to simplify their existence somewhat through
automation. Several theories of the process by which this occurs were developed in part
to help explain why some situations elicit a reasoned response from someone while other
situations are responded to automatically. One automaticity theory suggests that as a
person begins to learn a particular skill, he or she works through mental processing
algorithms (Logan, 1988). For example, during the beginning of her stay in a foreign
land, a traveler might perform a mental conversion of the price of items in a store to her
home currency each time she makes a purchase. Eventually she will recall from memory
rather than calculate prices for items frequently purchased. In this way, active
computation has been reduced or eliminated and the much less effortful process of
memory retrieval provides the information previously acquired through computation.
Another form of automaticity involves the caching of solutions to common problems. In much the same way people use shortcuts and automatic means of information processing, so too can they cache solutions to common problems for use at a later time. In fact, we can use the knowledge of a person’s tendencies to use the same solutions over and over in similar situations to predict their behavior (Markman & Gentner, 2001).

Through the process of categorization people classify things into categories and draw inferences from those categories. Categorization can be divided into domain-general processes such as the role of similarity, or domain-specific processes such as in the study of cross-cultural differences in categorization (Markman & Gentner, 2001). The concept of similarity refers to the comparing of stimulus objects with prototype objects in order to categorize new objects. These stored category prototypes are comprised of the most typical features of the members of the category it represents; new objects are placed into categories according to their similarity to the prototype.

*Mental Models*

In an attempt to understand how humans perceive and interact with their environment, scientists rely heavily on the concept of the mental model as a framework for understanding certain cognitive processes. Markman and Gentner (2001) broadly define mental models as “representation[s] of some domain or situation that supports understanding, reasoning, or prediction” (p.229), yet this definition is far from incontrovertible, and has been criticized as being so general that it does not accurately
differentiate mental models from knowledge systems. Rouse and Morris (1986) review several alternative definitions of mental models, recognizing that most theories are developed to explain a specific situation or phenomenon, and provide a general definition: a mental model is a “mechanism whereby humans generate descriptions of system purpose and form, explanations of system functioning and observed system states, and predictions of future system states” (p. 360). Mental models have been theorized to help individuals predict and explain behavior, draw inferences and make predictions, determine appropriate actions, recognize and remember relationships among system variables, understand expectations, and organize and process new information in a rapid and flexible manner (Cannon-Bowers, Salas, & Converse, 1993).

Two types of mental models are generally recognized: logical mental models and causal mental models. People form logical mental models in order to organize complex series of items and relationships when engaging in logical reasoning tasks. These models are developed as a way of organizing and categorizing information for a specific task, and are discarded after the task has been accomplished. Causal mental models, on the other hand, are mental representations used in reasoning that are based on long-term knowledge or theories. An example of this type of mental model is a mental simulation of events yet to occur. These simulations are qualitative rather than quantitative, in that they use imagery rather than calculations.

Hegarty and Just (1993) studied the processes by which people form mental models. They measured the time it took for individuals to solve a mechanical comprehension test when given a textual description, a diagrammatic description, or both.
They found evidence that subjects in all conditions were constructing mental models of the mechanical system they were asked to explain, but the group that was given text and diagrams performed better than those given one or the other. Subsequent eye-fixation analysis showed the readers were constructing mental models incrementally by reading and re-reading a line of text before integrating that information with the diagram. These diagram consultations are thus seen as elaborative—an aid in the formation of a mental model rather than as an aid in understating the text.

Although mental models are generally thought to be cognitive phenomena, there is some evidence that they have a motor component as some mental simulations have been linked to bodily movement. Schwartz and Black (1999) asked people to mentally simulate tilting either a wide or a narrow glass as far as they could without spilling the water it contained. They found people were usually quite inaccurate when asked to visualize and report how far they could tilt each glass, but when they closed their eyes and tilted empty glasses they were much more likely to report the correct angle. Kathleen Metz (1985) found children often used hand motions to simulate the motion of a turning gear when asked to predict in which direction a specific gear will rotate. Eventually the children developed decision rules (e.g. each gear turns the opposite direction from the one adjacent), and made decisions based on rules rather than mental simulations. These decision rules reduce or eliminate the need to engage in mental simulation by utilizing previously stored information, thereby reducing cognitive load. Gentner and Medina (1998) argue that the comparison of two or more mental representations allows for the extension and application of abstract knowledge from one setting to another. The more
similar the mental representations are to one another the more likely it is that knowledge will be extended and connections between concepts strengthened by the formation of a new decision rule. If two mental representations are very dissimilar it is likely that a new decision rule will not be formed, knowledge will not transfer from one model to the other, and there will be no decrease in cognitive load.

Mental models are also studied at the team level, though not without controversy. Klimoski and Mohammed (1994) provide a review of studies supporting and refuting the idea that teams can share a mental model or form a “shared cognition” (p.406). Klimoski and Mohammed also discuss the relative lack of empirical evidence with regard to group cognition, and cite as cause the difficulties in collecting such data. Endsley (1995), however, provides evidence suggesting shared mental models can be accurately assessed using self-report and behavioral observation methods. Training is also an integral factor in the relationship between mental models and team performance. Rouse, Cannon-Bowers, and Salas (1992) provide evidence that training teams to develop appropriate expectations of likely team behaviors and explanations of observed team behaviors enhances mental models and therefore improves performance. Cannon-Bowers, Salas, and Converse (1993) suggest cross-training team members may help them understand the roles and responsibilities of their teammates, and training team leaders to share their views of the task with their team may help standardize the mental model for the group.

In summary, though the definition of mental models may be in flux, there is no question as to their usefulness in understanding and explaining the way individuals and groups organize and retrieve information. There is clear evidence that mental models are
formed spontaneously and rapidly, and are revised as new information becomes available. There is evidence that suggests mental models may have a motor component, and that physical movement can aid in the formation of models. Mental models assist in the development of decision rules that guide future decisions and reduce cognitive load. Though the study of team mental models has been stymied by the relative difficulties in measurement, familiar methods are gaining credence from empirical studies and new techniques are being developed to address this issue.

Critical Thinking

The study of critical thinking has been plagued by the lack of a unanimously agreed-upon conception of the term. In fact, it has been said that there are as many definitions of critical thinking as there are experts in the field (Benderson, 1990). Fasko (2003) reviews nearly two dozen such definitions coming from the fields of education, philosophy, and psychology. Each of these fields includes in their list of crucial characteristics for critical thinking a slightly different set of behaviors, thoughts, and qualities, and there is a great deal of disagreement regarding the underlying processes and key requirements for something to be considered critical thinking. John Dewey developed the first universal definition of what we now call critical thinking when he proposed his notion of reflective thinking, which is the “active, persistent, and careful consideration of any belief or supposed form of knowledge in the light of the grounds that support it and the further conclusions to which it tends… [It] includes conscious and voluntary effort to establish belief upon a firm basis of evidence and rationality” (Dewey,
Dewey further restricted his definition to say that “efforts to establish beliefs based on evidence and rationality” (p. 9) could only be considered critical thinking if they were both conscious and voluntary.

In what may be the most thorough attempt to obtain consensus to date, a panel of experts in critical thinking instruction, assessment, and theory was convened in February of 1988 to systematically study the nature and assessment of critical thinking (Facione, 1990). Over the next seventeen months, these forty-six experts used the Delphi technique (Linstone & Turoff, 1975), an iterative, collaborative process often used to reach consensus on conceptual definition or other problems not amenable to more quantitative inquiry, to define the criteria of elements comprising critical thinking. Their findings resulted in the identification of an affective disposition component to critical thinking and a cognitive skill component (Facione, 1990). This two-factor model of critical thinking that was developed through expert consensus was later buttressed by empirical research. Taube (1997) tested college students’ educational values, need for cognition, ambiguity tolerance, and critical thinking ability (as measured by the Watson-Glaser Critical Thinking Appraisal and the Ennis-Weir Critical Thinking Essay Test). They also collected college GPA and SAT verbal and math scores. Confirmatory factor analysis showed the two-factor (ability and disposition) model provides a better fit with the obtained data than a one-factor model (GFI = .955 versus .869, respectively). Taube cautions that general mental ability may be partly or largely influencing the critical thinking ability score. In fact, the factor loadings of SAT-math and SAT-verbal on the critical thinking dimension were both higher than the Watson-Glaser measure, and the
Ennis-Weir test’s loading on the ability factor of the two-factor was more than double its loading on the disposition factor, though it was assumed it would measure both critical thinking ability and disposition.

The study of critical thinking is unfortunately somewhat intertwined with the concept of intelligence. We cannot in good conscious discuss critical thinking without at least acknowledging its relationship with g. g is defined as “the ability to deal with complexity” (Gottfredson, p.29), and as such must be included in the discussion of critical thinking at least as it is measured by complex tasks. There is evidence, however, that other forms of intelligence such as tacit knowledge or practical intelligence may predict performance on situational judgment tests or simulation exercises (a common method for assessing critical thinking) better than g (Sternberg & Hedlund, 2002).

The first major documented case of the assessment of critical thinking resulted from an experiment Edward Glaser conducted to assess the thinking skills of high school students (Glaser, 1941). He identified three components of critical thinking: a disposition to carefully consider the problems one encounters, knowledge of logical reasoning methods, and the ability to apply those methods. These findings became the beginnings of a stream of research that would lead to the eventual development of the Watson-Glaser Critical Thinking Appraisal (Watson & Glaser, 1980). Glaser, now armed with a tool to assess his success, set out to teach critical thinking. His training program consisted of eight lessons related to critical thinking, such as evidence, attitude, prejudice, and the scientific method. He obtained evidence suggesting the successful teaching of critical thinking in that the group that had received his training performed significantly better
than the group that did not, but his findings were tempered by the subsequent realization that the obtained critical thinking scores were significantly correlated with intelligence measures (.46) and reading comprehension (.77) (Facione, 1984).

Since that time critical thinking has been studied in nearly every academic discipline, particularly nursing (see Simpson & Courtney, 2002 for a review) and education (e.g. Meyers 1996).

Critical Thinking in Industrial and Organizational Psychology

One of the ways critical thinking is linked directly to industrial and organizational psychology is through task complexity. Task complexity is invariably linked to critical thinking because the ability to successfully engage a complex task often requires a degree of intelligence and the ability to think critically. The impact that general mental processing ability (g) has on performance is evident in everyday tasks but is most evident in “higher order thinking skills such as reasoning, abstract thinking, and problem solving” (Gottfredson, 2002, p.27). These higher order thinking skills are among those generally considered requisite of critical thinking (Fasko, 2003; Facione, 1990).

Performance management and assessment are often troublesome in even simple jobs, but the task is exponentially more difficult when the performance to be assessed involves critical thinking. Molleman and Timmerman (2003) found it difficult to assess the knowledge and skills requisite of some of the complex jobs they assessed, in part due to the high degree of creativity and specialization. They also found a great deal of teamwork among those workers who thought critically as part of their jobs, and therefore
stress the importance of being aware of the influence of team members when assessing
the performance of those workers who are likely to think critically.

_Cognitive Skills and Critical Thinking_

Six cognitive skills are thought to be employed by good critical thinkers: analysis,
evaluation, explanation, inference, interpretation, and self-regulation (Facione, 1990, see
Table 1). These six skills are thought to be as trainable and teachable as other skills. In
fact, research has long been conducted in the fields of education and nursing regarding
training and evaluating critical thinking skills in students and nurses (for a review of the
education literature see Meyers, 1986; for a review of the nursing literature see Simpson
& Courtney, 2002).
Table 1

*Cognitive skills of critical thinkers (Facione, 1990).*

<table>
<thead>
<tr>
<th>Dimension</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Analysis</td>
<td>Identifying the intended and actual inferential relationships among statements intended to express belief, judgment, experiences, reasons, information, or opinions</td>
</tr>
<tr>
<td>Evaluation</td>
<td>Assessing the credibility of statements or other representations, and to assess the logical strength of the actual or intended inferential relationships among those statements.</td>
</tr>
<tr>
<td>Explanation</td>
<td>Justifying and explaining one’s reasoning in terms of the evidential, conceptual, methodological, criteriological, and contextual considerations upon which one’s results were based.</td>
</tr>
<tr>
<td>Inference</td>
<td>Identifying and securing elements needed to draw reasonable conclusions. Forming conjectures and hypotheses, considering relevant information and resulting consequences.</td>
</tr>
<tr>
<td>Interpretation</td>
<td>Comprehending and expressing the meaning or significance of a wide variety of experiences, situations, data, events, judgments, conventions, beliefs, rules, procedures, or criteria.</td>
</tr>
<tr>
<td>Self-regulation</td>
<td>Monitoring the elements and the results of one’s cognitive activities. Applying the skills of analysis and evaluation to one’s own inferential judgments with a view toward questioning, confirming, validating, or correcting one’s reasoning or results.</td>
</tr>
</tbody>
</table>
Affective Dispositions and Critical Thinking

Although cognitive skills and situational factors influence the ability of someone to think critically, it does not explain why some people seem to think critically often in a given situation while others rarely do. If someone has all the requisite skills to think critically but fails to do so, and a situational explanation cannot be found, it stands to reason that there is a dispositional explanation for the lack of critical thinking. Based on this observation, scientists and educators began looking for those internal factors which cause an otherwise capable individual to engage in critical thinking or not. They were looking for the “critical spirit” of the critical thinker, that way of living that is consistent with critical thinking (Facione, 1998). It was agreed that critical thinkers are analytical, inquisitive, judicious, open-minded, systematic, truth-seeking and possess cognitive maturity (see table 2).
Table 2

*Affective dimensions of critical thinking (Facione, Sanchez, & Facione, 1994).*

<table>
<thead>
<tr>
<th>Dimension</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Analyticity</td>
<td>Prizing the application of reasoning and the use of evidence to resolve problems, anticipating potential conceptual or practical difficulties and consistently being alert to the need to intervene</td>
</tr>
<tr>
<td>Inquisitiveness</td>
<td>Being intellectually curious and possessing a desire to learn even when the application of the knowledge is not readily apparent</td>
</tr>
<tr>
<td>Open-mindedness</td>
<td>Being tolerant of divergent views and sensitive to the possibility of one’s own bias</td>
</tr>
<tr>
<td>Systematicity</td>
<td>Being organized, orderly, focused and diligent in inquiry</td>
</tr>
<tr>
<td>Truth-seeking</td>
<td>Being eager to seek the best knowledge in a given context, courageous about asking questions, and honest and objective about pursuing inquiry even if the findings do not support one’s self-interests or preconceived notions.</td>
</tr>
<tr>
<td>Cognitive Maturity</td>
<td>Trusting one’s own reasoning processes and the ability to lead others in the rational resolution of problems</td>
</tr>
<tr>
<td>Judiciousness</td>
<td>Approaching problems, inquiry, and decision-making with a sense that some problems are necessarily ill-structured, and many times judgments must be made on standards, contexts and evidence which preclude certainty.</td>
</tr>
</tbody>
</table>
**Training**

Though there have been many advances in the study of training throughout the last twenty years, three factors consistently emerge: needs assessment, training methodology, and training evaluation. According to Wexley (1984), needs assessment answers three questions: where should training be placed, what needs to be trained, and who needs the training? Latham (1988) provides four methods for identifying training needs: organization analysis, task analysis, person analysis, and demographic analysis. In conducting an organization analysis the training program is linked to the goals of the organization and is designed to minimize the technical obsolescence of the organization’s members. The task analysis evaluates the tasks that the recipients of the training will be required to do, taking care to anticipate the requirements of the job likely in the near future. A person analysis is conducted to determine who needs training. Interviews with trainers and managers, surveys, and self-nomination are all methods of conducting person analyses. A demographic analysis is conducted to determine the training needs of entire populations of workers. These studies are often inter-organizational and focus on groups such as workers over fifty or on female managers (Latham, 1988).

A successful training method is designed to achieve four goals: presentation of relevant information or concepts to be learned, demonstration of the knowledge, skills, and abilities (KSAs) to be learned, create opportunities for trainees to practice the skills, and provide feedback to trainees during and after practice. (Salas & Canon-Bowers, 2001). Training methodology is constantly evolving. Computer-based training has been used for approximately twenty years, and has been consistently successful (Wexley,
1984), though now when we talk of computer-based training we are usually speaking of distributed or distance learning. The convenience and savings of time and money that Web-based training programs offer make them an attractive alternative to more traditional methods. These new tools have greatly impacted the way training is conducted, but we don’t know as much about the learning processes that occur with the use of these media as we do about face-to-face classroom training (i.e., what level of interaction between trainer and student is needed for effective knowledge transfer and retention?) (Salas and Canon-Bowers, 2001). In addition to computer-based training, simulators and simulation games are very popular training methods. Though the cognitive processes and training design of these methods have been largely ignored, simulation and behavior role modeling are usually effective in producing immediate training effects as well as long-term retention (Salas and Canon-Bowers, 2001).

*Training Critical Thinking*

There is a great deal of interest in training people to be good critical thinkers. Nearly everyone, from teachers to employers to military leaders has an interest in developing the critical thinking skills of their charges. Latham (1988) predicted “jobs of the future will require less memorizing of facts and procedures, fewer physical skills, and far more conceptual ability” (p.550). There is little disagreement that cognitive skills can be trained; these are seen as developable skills in much the same way artistic or leadership skills can be developed (Facione, Facione and Giancarlo, 2000). Where there is disagreement, however, is in whether affective dispositions can be trained. That is, can
we train someone to behave in a manner that is consistent with a disposition toward
critical thinking? Perkins and Tishman (1993) argue that the engagement in critical
thinking is indicative of a disposition toward critical thinking, but their argument requires
the ability for people to choose their activity. We hope to determine whether people,
given the knowledge of critical thinking dispositions, can perform the behaviors
associated with these dispositions in the context of thinking critically.

Hypotheses

1. Teams receiving instruction in the use of affective dispositions and cognitive skills
   will exhibit these characteristics more during a critical-thinking task.
   a. Teams in the cognitive skills condition will use cognitive skills to a greater
      extent than teams in the control or affective dispositions condition, as
      measured by both the behavioral and self-report ratings.
   b. Teams receiving training in affective dispositions will use affective
      dispositions to a greater extent than teams in the control or cognitive skills
      condition, as measured by both the behavioral and self-report ratings.
   c. Teams receiving both cognitive skills training and affective dispositions
      training will use both affective dispositions and cognitive skills to a greater
      extent than teams in the control condition, as measured by both the behavioral
      and self-report ratings.

2. Behavioral measures of cognitive skills will correlate with the self-report measure of
cognitive skills.

4. Teams displaying evidence of affective dispositions and cognitive skills perform better on critical-thinking tasks.
   a. The expert performance rating will be significantly and positively correlated with the affective dispositions self-report score.
   b. The expert performance rating will be significantly and positively correlated with the affective dispositions behavioral observation score.
   c. The expert performance rating will be significantly and positively correlated with the cognitive skills self-report score.
   d. The expert performance rating will be significantly and positively correlated with the cognitive skills behavioral observation score.

5. Affective dispositions are closely related to the personality variable openness to experience.
   a. The behavioral measure of affective disposition will be highly correlated with the personality measure of openness to experience.
   b. The self-report measure of affective disposition will be highly correlated with the personality measure for openness to experience.
Method

Participants

One hundred-twenty students self-selected into the study from the USF Psychology Subject Pool. The age of the participants ranged from 18 to 50, averaged 21.9 years (SD=5.13), with a median of 20. Each subject had worked an average of 4.74 years (SD=3.83), ranging from zero to twenty years. The median number of years of work experience was four. Participants worked in three-person teams and were given extra-credit in their classes in consideration of their participation.

Materials

Tactical Decision Games

We used a modified version of two Tactical Decision Games (TDGs) reprinted from The Marine Corps Gazette (Schmitt, 1994). These paper-based scenarios are used by military leaders as instructional aids to teach tactics, operations, and strategy. The TDGs were modified to remove military terms that would hinder their understanding by non-military undergraduate students and then used to stimulate and measure critical thinking.

Exit Questionnaire

This is a 26-item questionnaire developed by the researchers. It asked participants to rate the performance of their group in effective team functioning, cognitive skills, and affective dispositions. Participants indicated their agreement to questions such as “My team had clear agreement on priorities” on a five-point Likert scale anchored at strongly disagree and strongly agree.
Personality Measure

This 60-item measure was developed with questions from the international personality item pool. It is comprised of the 50-item “Big Five Domain” scale and the 10-item “Openness to Experience” scale (Goldberg, 1999).

TinkerToy® project

TinkerToys® are a children’s toy made of wooden rods and connecting pieces. Three 66-piece junior builder TinkerToy® sets were combined, then divided into groups of like shape and function and placed into new bins. One bin contained all connector pieces, another all long rods, and the last bin contained medium-sized rods and wheels.

Procedure

Each team was welcomed and told they will be studying team dynamics during problem-solving tasks. After informed consent, consent to videotape, and demographic information was gathered, the participants were asked to read along while listening to an informative audio recording. Depending on condition, participants received instruction in either cognitive skills used in critical thinking, affective dispositions of critical thinkers, both of these, or neither of these. Those groups that did not receive training in both cognitive skills and affective dispositions listened to training tapes on choosing college classes or conducting a job search, such that they will have listened to a total of two training tapes.

Assignment cards were then distributed to those groups who had listened to the cognitive skills tape and/or the affective dispositions tape. These cards list one of the
cognitive skills or affective dispositions and its definition. Participants were instructed to ensure the group engages in the skill or disposition they had been given. Teams received a short training on effective teams and team building.

Each team was then asked to complete an “icebreaker” exercise, designed to enable communication and cooperation, in which they built a tower of TinkerToys®. The participants were reminded of the qualities of effective teams before the task began. Teams were given one of the bins of TinkerToys and were instructed to build a tower as tall as possible within fifteen minutes. They were limited by the inability to touch only the pieces that came from their bin; they were not allowed to touch their teammates’ pieces. A discussion followed during which the team members examined their team and individual performance and the degree to which they used their assignment cards and reminded the group to exhibit the listed characteristics. They then discussed ways to improve in future tasks, and were reminded of their assignment to ensure the group exhibits the characteristics on their cards.

Next, participants were given their first Tactical Decision Game (TDG). The group was again reminded of effective habits of teams, and was then presented with the scenario and answer sheets. The group was asked to determine and prioritize their goals, issue orders and justifications to the people under their command, and to use a map to provide a visual aid to assist the researchers in understanding their solution. Teams engaged in a discussion after the scenario in which they evaluated their performance and reminded to use their assignment cards in the next task.
The second TDG was given in the same manner as the first, with a reminder of the qualities of effective teams. This scenario lasts up to an hour and is videotaped. The participants then each completed a personality measure, and an exit questionnaire.

Scoring

SME Rating

A military expert used a five-point scale to rate the military effectiveness of the orders given in each team’s solution to the second TDG. This score serves as an objective measure of task performance based on performance-relevant criteria.

Behavioral Rating

After training to an acceptable level of agreement, three graduate students individually viewed and rated the videotape of the second TDG of each group. The frequency of exhibition of each of the six cognitive skills and seven affective dispositions were made, as well as an overall rating (one to five) on each of these 13 dimensions.

Self-report

Team members were asked to complete a 24-item questionnaire assessing the degree to which their team engaged in each of the thirteen affective dispositions and cognitive skills, and assessed the degree to which the team members engaged in effective team processes.

Results

The ratings of the three judges completing the behavioral ratings of cognitive skills and affective dispositions evidence a high level of inter-judge agreement (type C
A one-way between-subjects multivariate analysis of covariance (MANCOVA) including the TDG expert rating, all the 34 dependent variables and three covariates listed in table 3 achieved multivariate significance ($F_{(90,246)} = 1.647, p=0.001$). The covariates of age, gender, and work experience, however, were not significant ($F_{(30,80)} = 0.603, p>0.05$; $F_{(30,80)} = 0.792, p>0.05$; $F_{(30,80)} = 1.116, p>0.05$, respectively), and were thus removed from future analysis. A one-way between-subjects multiple analysis of variance (MANOVA) was run on the remaining variables. This resulted in an overall significant main effect for experimental condition ($F_{(90,252)} = 1.551, p<0.01$). Subsequent univariate analysis revealed a significant main effect for condition on subject matter expert (SME) ratings ($F_{(3,113)}=5.784, p<.001$). A Games-Howell post-hoc analysis of the SME ratings reveals the cognitive condition and the control condition scored higher than the affective group condition (mean difference=0.7761, $p<0.001$ and 0.3937, $p<0.05$, respectively).

The overall behavioral ratings of each team reveal a difference among teams with regard to the affective disposition of truth-seeking. Those teams that received affective dispositions training (M=3.62, SD=0.846) received a higher overall rating on the truth-seeking dimension of the behavioral rating than did the control group (M=2.88, SD=0.878). The Games-Howell test shows this difference is significant at the $p<.01$ level. The behavioral ratings show a strong correspondence with the subject matter expert ratings ($r=0.80, p<.01$), such that more behavioral expression of cognitive skills and affective dispositions was associated with better solutions to the problem scenario as judged by the subject matter expert.
Figure 1

Subject matter expert ratings by training condition.
Figure 2

Behavioral observation of Truthseeking dimension by training condition.
Table 3

Variables used in multivariate analysis of covariance.

<table>
<thead>
<tr>
<th>Independent Variable (1)</th>
<th>Experimental condition (training in cognitive skills, affective dispositions, both, or neither)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>TDG expert rating (1) [Behavioral ratings (30)]</td>
</tr>
<tr>
<td></td>
<td>a. Frequencies of affective dispositions exhibited, by dimension (7)</td>
</tr>
<tr>
<td></td>
<td>b. Frequencies of cognitive skills exhibited, by dimension (6)</td>
</tr>
<tr>
<td></td>
<td>c. Total affective dispositions frequency (1)</td>
</tr>
<tr>
<td></td>
<td>d. Total cognitive skills frequency (1)</td>
</tr>
<tr>
<td></td>
<td>e. Global rating (1-5) for each category (13)</td>
</tr>
<tr>
<td></td>
<td>f. Total global rating for cognitive skills (1)</td>
</tr>
<tr>
<td></td>
<td>g. Total global rating for affective dispositions (1)</td>
</tr>
<tr>
<td></td>
<td>[Self-report measures (6)]</td>
</tr>
<tr>
<td></td>
<td>a. Affective disposition utilization self-report individual score (1)</td>
</tr>
<tr>
<td></td>
<td>b. Affective disposition utilization self-report team score (1)</td>
</tr>
<tr>
<td></td>
<td>c. Cognitive skills utilization self-report individual score (1)</td>
</tr>
<tr>
<td></td>
<td>d. Cognitive skills utilization self-report team score (1)</td>
</tr>
<tr>
<td></td>
<td>e. Team processes self report individual score (1)</td>
</tr>
<tr>
<td></td>
<td>f. Team processes self report team score (1)</td>
</tr>
<tr>
<td>Covariates (8)</td>
<td>[Personality (5)], [Age (1)], [Sex (1)], [Work experience (1)]</td>
</tr>
</tbody>
</table>
Variables analyzed.
Discussion

This study sought to shed light on the influence of cognitive skills and affective dispositions on team processes and outcomes on a critical-thinking task, to determine which if any of the dimensions of critical thinking are trainable, and to do it using objective measures when possible. Since our subject matter expert was unknown to both participants and researchers and saw only the participants’ solutions, his or her ratings are very objective ratings of critical thinking from an outcome perspective. A larger challenge is developing objective process measures. The lack of a generally agreed-upon taxonomy of critical thinking made the development of behavior-based scoring much more difficult. This study provides evidence of the potential value of behavioral observation in the study of critical thinking in teams.

Based on our subject matter expert outcome ratings, we found the cognitive and control groups provided better solutions to the scenario than did the affective group. Although not a significant difference, the “both” group tended toward the affective group. This may indicate a deleterious effect of the affective training (as both groups received it), or of the instruction to exhibit the characteristics described on their reminder cards. Affective dispositions are generally harder to understand and integrate than cognitive skills, and the additional attention required to implement the requested behavioral changes could have detracted from their ability to complete the task assigned.

In behavioral ratings, we found the affective dispositions group exhibited an overall score on truthseeking that was higher than the control group. This finding suggests the affective dispositions training worked, that it increased the extent to which
the teams engaged in truthseeking. If this difference was based solely on the affective dispositions training we would expect to see a significant difference between the affective dispositions group and the cognitive skills group, as they received no affective dispositions training. A possible explanation for the lack of a significant difference is the high degree of overlap between the six cognitive skills dimensions and the truthseeking affective dispositions dimension. The correlations range from .32 to .45 and are all significant at p=.05.

In addition to the findings relating to the trainability and performance influence of cognitive skills and affective dispositions, this study developed a unique behavioral analysis technique in order to objectively measure the expression of cognitive skills and affective dispositions in group interactions.

In the course of conducting this experiment several researchers noted that although the training sessions were somewhat tedious for all participants, they seemed to be especially arduous for those in the “both” condition. Indeed, these participants were trained in cognitive skills followed immediately by training in affective dispositions whereas those in the “cognitive skills” or “affective dispositions” condition received one or the other, followed by training in conducting a job search or choosing college classes. We believe the different training programs were differentially relevant to the participants’ lives, and that this difference may have affected our ability to draw conclusions regarding the efficacy of our training program. This difference can be seen in the responses to question 23 of the exit questionnaire (see appendix D), which asks participants to rate the degree to which they enjoyed the exercise. There is a small but compelling trend, in
which the groups that received the most life-relevant training (the control group) enjoyed
the experiment more than the groups that received no life-relevant training (the “both”
condition), and the two groups that received one life-relevant training each were in
between. This effect did not achieve significance in our study but we believe a larger
sample would find significant differences. Future studies should take this into account
when designing training for control groups.

The data from behavioral analysis are rich and can provide information that
cannot be obtained through other means, particularly in the realms of collaborative
critical thinking and team processes. Though there is inherent value in the collection and
analysis of critical thinking data independent of outcome measures, it is heartening to see
such a high correlation (.80) with established measures of critical thinking. This lends
further credence to the behavioral method developed in this study, and to the taxonomy
that underlies it.
References


Appendices
Appendix A: Command and Control Fog Tactical Decision Game

Command and Control Fog

In this handout you will find three things to use: a situation description (this page), a map (page 2), and a key for the map (page 3). Please use all three to complete your task.

Situation

You are commanding a group of soldiers assigned to a joint task force (JTF) conducting humanitarian relief operations in the drought stricken country of Nepotonia. In support of a United Nations goal, your mission is to produce drinkable water and fill local cisterns (water tanks). The likelihood of terrorist activity in this area has you operating on a heightened state of alert. Although terrorists have raided cisterns throughout the area, there have been no cistern raids in your particular area of operations.

The JTF commander is concerned that cistern raids may lead to civil unrest in Nepotonia and ultimately upset the balance of power in the region. For diplomatic reasons, the JTF commander decided to follow the U.N. task force's restricted rules of engagement (i.e., individual weapons may be carried, but you may only engage an enemy when fired upon.) Your resources are listed in the box to the right.

Routes 1, 4, 7, and 9 are paved roads, and routes K, X, and Z are dirt roads. The commercial tankers cannot navigate on dirt roads.

For protection you have limited convoy size to 15 vehicles, varied convoy departure times, and directed your engineer company to pave routes K, X, and Z. Additionally, commercial tankers have been included in the convoys, and tactical vehicles with mounted machineguns are in the front and rear of each convoy.

On the 31st day of your mission, you launch a convoy from your command post (CP) to Village 2. Your engineer company commander has completed paving Route K. He is working in the vicinity of checkpoint 4 and anticipates completing Route X in 5 days. You are located in your command post.

The lead element of the convoy has passed checkpoint 8 and is proceeding east when the convoy commander, a staff sergeant, reports hearing an explosion and seeing a column of heavy black smoke east of checkpoint 2. The excited staff sergeant reports two off-road vehicles (ORVs) approaching the convoy from the north at a high rate of speed. After forcing a tanker off the road and causing it to sink in the loose sand, the ORVs retreated to the hills north of the road. The staff sergeant states that the ORVs appeared to have gun mounts, but he did not see any guns.

While talking to the staff sergeant you hear the unmistakable sound of machinegun fire.

The staff sergeant confirms machinegun fire coming from the vicinity of the rear of his convoy but states that he cannot see the rear of his convoy.

Task Organization

Motor Transport Company
Engineer Company
Detachment, Engineer Support Company
Detachment, Communications Company
250 additional personnel

Major Equipment

10 x logistics vehicle systems/command vehicles
6 x 600-gallon water tanks
Reverse osmosis water purification equipment
2 x road graders
1 x bulldozer
4 x 5-ton dump trucks
4 x 10k TRAMs (tractor, rubber-tired, articulated steering, multipurpose) w/clamshell bucket
10 x assorted HMMWVs (hummers)

Non-military Equipment

10 x 7-ton commercial tanker trucks w/drivers

Requirement

From your command post 12 kilometers away, what orders do you give to your subordinates, and what do you tell higher headquarters? Provide the rationale for your actions and a sketch of your plan.
- **Command Post**
- **Checkpoint**
- **Paved Road**
- **Dirt Road**
- **Water / Mud**
- **Water Source**

**KEY**
Appendix B: Ambush at Dusk Tactical Decision Game

Ambush at Dusk

In this handout you will find three things to use: a situation description (this page), a map (page 2), and a key for the map (page 3). Please use all three to complete your task.

Situation
You are the leader of the 1st Squad within the 1st Platoon of Company C. You are fighting in a tropical area against rebel forces armed with handguns, light machineguns, and sometimes rocket-propelled grenades. Recently, Company C has been conducting patrols (on foot) in a populated region to counter increased rebellious activity. Today, your platoon, with a machinegun squad accompanying, is running a security patrol along a designated route. You are to attack and destroy any enemy forces you locate. Sunset is approaching within the hour. Your squad is in the lead position of the platoon, some 200 yards ahead of the main platoon group, advancing north through a rice paddy (a flooded field where rice is grown), paralleling a 2-foot-high retaining wall to your right. You have learned from experience not to walk on the walls or trails because they are frequently booby-trapped. Although it is more uncomfortable, it is generally much safer to travel through the rice paddies. To your west is a village. East of the wall is another rice paddy and another small village.

As your squad crosses a trail at the northern edge of the paddy, one of your soldiers accidentally sets off a booby trap, suffering a severe leg wound. Suddenly, the enemy opens fire with automatic weapons from the village to the west, and the platoon commander (a lieutenant) is hit. The continual shooting from the village has the 2nd and 3rd squads pinned down in the rice paddy. After tending to the wounded lieutenant, the medic courageously makes his way forward under fire to your squad’s position, followed shortly by part of the machinegun squad. The medic tells you that the lieutenant is severely hurt. You wish you had a radio, but the platoon’s radioman is pinned down near the lieutenant. The enemy fire against your position is erratic; the two squads (2nd and 3rd) in the paddy are returning fire but appear unable to move. You estimate that the sun will disappear within a half hour. You have no communication with the platoon second-in-command (a sergeant). What do you do?

Requirement
Draft the order you would issue to your team leaders and describe any additional actions you would take. Include an overlay sketch and provide a brief explanation of the rationale behind your action.

Force Structure

![Force Structure Diagram]

Company C

1st Platoon
Commander: Lieutenant
2nd in Command: Sergeant

1st Squad
Leader/Corporal: You (10 soldiers)

2nd Squad

3rd Squad

Team 1
Team 2

40
Appendix C: Personality Measure

The following phrases describe people's behaviors. Please use the rating scale below to describe how accurately each statement describes you. Describe yourself as you generally are now, not as you wish to be in the future. Describe yourself as you honestly see yourself, in relation to other people you know of the same sex as you are, and roughly your same age. So that you can describe yourself in an honest manner, your responses will be kept in absolute confidence. Please read each statement carefully and circle the number that corresponds to one of the following options:

<table>
<thead>
<tr>
<th></th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Very Inaccurate</td>
<td>Moderately Inaccurate</td>
<td>Neither Inaccurate nor Accurate</td>
<td>Moderately Accurate</td>
<td>Very Accurate</td>
</tr>
<tr>
<td>2.</td>
<td>I often feel blue.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>3.</td>
<td>I have frequent mood swings.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>4.</td>
<td>I avoid philosophical discussions.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>5.</td>
<td>I sympathize with others' feelings.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>6.</td>
<td>I feel little concern for others.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>7.</td>
<td>I pay attention to details.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>8.</td>
<td>I shirk my duties.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>9.</td>
<td>I am quick to understand things.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>10.</td>
<td>I am not interested in abstract ideas.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>11.</td>
<td>I feel comfortable around people.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>12.</td>
<td>I have difficulty understanding abstract ideas.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>13.</td>
<td>I take time out for others.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>14.</td>
<td>I have a vivid imagination.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>15.</td>
<td>I don't like to draw attention to myself.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>16.</td>
<td>I enjoy hearing new ideas.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>17.</td>
<td>I worry about things.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>18.</td>
<td>I get irritated easily.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>19.</td>
<td>I am full of ideas.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>20.</td>
<td>I am the life of the party.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>21.</td>
<td>I have a rich vocabulary.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>22.</td>
<td>I leave my belongings around.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>23.</td>
<td>I spend time reflecting on things.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>24.</td>
<td>I have excellent ideas.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>25.</td>
<td>I get chores done right away.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>26.</td>
<td>I don't mind being the center of attention.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>27.</td>
<td>I believe in the importance of art.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>28.</td>
<td>I am not interested in abstract ideas.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
</tbody>
</table>
Appendix D: Exit Questionnaire

<table>
<thead>
<tr>
<th>Team Number</th>
<th>Team Member</th>
<th>Condition</th>
</tr>
</thead>
</table>

**TEAM QUESTIONNAIRE**

This questionnaire contains a series of statements to which you are asked to respond as indicated. Please complete these questionnaires individually.

### Team Process

1. My team communicated with each other clearly as we solved the problem. Circle number.

<table>
<thead>
<tr>
<th>Strongly Disagree</th>
<th>Disagree</th>
<th>Neither Agree Nor Disagree</th>
<th>Agree</th>
<th>Strongly Agree</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
</tbody>
</table>

2. As we discussed the problem and developed our solution, my team stayed on task. Circle number.

<table>
<thead>
<tr>
<th>Strongly Disagree</th>
<th>Disagree</th>
<th>Neither Agree Nor Disagree</th>
<th>Agree</th>
<th>Strongly Agree</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
</tbody>
</table>

3. If we made an error (e.g., mis-read the map), my team promptly corrected it. Circle number.

<table>
<thead>
<tr>
<th>Strongly Disagree</th>
<th>Disagree</th>
<th>Neither Agree Nor Disagree</th>
<th>Agree</th>
<th>Strongly Agree</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
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</tbody>
</table>


<table>
<thead>
<tr>
<th>Strongly Disagree</th>
<th>Disagree</th>
<th>Neither Agree Nor Disagree</th>
<th>Agree</th>
<th>Strongly Agree</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
</tbody>
</table>

5. One member of my team assumed a leadership role. Circle number.

<table>
<thead>
<tr>
<th>Strongly Disagree</th>
<th>Disagree</th>
<th>Neither Agree Nor Disagree</th>
<th>Agree</th>
<th>Strongly Agree</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
</tbody>
</table>
6. My team had clear agreement on priorities. Circle number.

<table>
<thead>
<tr>
<th>Strongly Disagree</th>
<th>Disagree</th>
<th>Neither Agree Nor Disagree</th>
<th>Agree</th>
<th>Strongly Agree</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
</tbody>
</table>

7. My team was effective in making decisions. Circle number.

<table>
<thead>
<tr>
<th>Strongly Disagree</th>
<th>Disagree</th>
<th>Neither Agree Nor Disagree</th>
<th>Agree</th>
<th>Strongly Agree</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
</tbody>
</table>

8. My team was effective at solving problems. Circle number.

<table>
<thead>
<tr>
<th>Strongly Disagree</th>
<th>Disagree</th>
<th>Neither Agree Nor Disagree</th>
<th>Agree</th>
<th>Strongly Agree</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
</tbody>
</table>

9. In developing our solution, my team used all available information. Circle number.

<table>
<thead>
<tr>
<th>Strongly Disagree</th>
<th>Disagree</th>
<th>Neither Agree Nor Disagree</th>
<th>Agree</th>
<th>Strongly Agree</th>
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<td>1</td>
<td>2</td>
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</tbody>
</table>

Cognitive Skills. The following statements assess selected cognitive skills that you may have employed during the exercise.

10. My team was able to interpret the facts we were provided. Circle number.

<table>
<thead>
<tr>
<th>Strongly Disagree</th>
<th>Disagree</th>
<th>Neither Agree Nor Disagree</th>
<th>Agree</th>
<th>Strongly Agree</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
</tbody>
</table>
11. My team *analyzed* the situation. Circle number.

<table>
<thead>
<tr>
<th>Strongly Disagree</th>
<th>Disagree</th>
<th>Neither Agree Nor Disagree</th>
<th>Agree</th>
<th>Strongly Agree</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
</tbody>
</table>

12. My team *evaluated* alternative solutions. Circle number.

<table>
<thead>
<tr>
<th>Strongly Disagree</th>
<th>Disagree</th>
<th>Neither Agree Nor Disagree</th>
<th>Agree</th>
<th>Strongly Agree</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
</tbody>
</table>

13. My team was able to *infer* sufficient facts to develop a solution. Circle number.

<table>
<thead>
<tr>
<th>Strongly Disagree</th>
<th>Disagree</th>
<th>Neither Agree Nor Disagree</th>
<th>Agree</th>
<th>Strongly Agree</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
</tbody>
</table>

14. My team was able to *explain* the rationale for solutions. Circle number.

<table>
<thead>
<tr>
<th>Strongly Disagree</th>
<th>Disagree</th>
<th>Neither Agree Nor Disagree</th>
<th>Agree</th>
<th>Strongly Agree</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2</td>
<td>3</td>
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15. My team was *self-regulating* as we worked together. Circle number.

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<th>Neither Agree Nor Disagree</th>
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21. My team members displayed an *analytical* spirit. Circle number.

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22. My team’s approach was *systematic*. Circle number.

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**Questions about the exercise.**

23. I enjoyed participating in this exercise.

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24. Participating in this exercise was generally a waste of my time.

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25. What did you *like most* about the exercise?

26. What did you *like least* about the exercise?
### Appendix E: Behavioral Rating Form

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