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BIAS AND BIAS REMEDIATION IN CREATIVE PROBLEM-SOLVING: MANAGING BIASES THROUGH FORECASTING

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ERIN MICHELLE TODD
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BIAS AND BIAS REMEDIATION IN CREATIVE PROBLEM-SOLVING:
MANAGING BIASES THROUGH FORECASTING

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BY

____
Dr. Michael Mumford, Chair

____
Dr. Shane Connelly

____
Dr. Edward Cokely

Dedicated to Cherie.

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Abstract

Although scholars have identified many variables that affect creative problem-solving, less attention has been given to variables that might lead to failure in creative problem-solving. One set of variables that might lead to poor performance in creative problem-solving is decision biases. In the present study, we examined the impact of simple and complex decision biases on the production of original, high quality, and elegant solutions to a creative problem-solving task. In addition, we examined the value of forecasting instruction as a technique for reducing these decision biases. It was found that both simple and complex decision biases resulted in problem solutions of lower originality, quality, and elegance. Training in viable forecasting strategies resulted in the production of higher quality problem solutions. The implications of these findings for improving creative problem-solving performance are discussed.

Keywords: creativity, creative problem-solving, bias, forecasting

Introduction

The quest to understand creativity (the production of original, high quality, and elegant solutions to complex, novel, ill-defined problems) is a quest of noteworthy importance (Besemer & O'Quin, 1998; Christiaans, 2002; Mumford & Gustafson, 2007). As creative scholars have pointed out, the basis for the innovative new products and services that advance humanity lies in peoples' creativity (Mumford, Medeiros, & Partlow, 2012; Weisberg, 2011). Recognition of this point has led to an ongoing stream of research intended to identify the capacities and conditions that make creative problem-solving possible (Runco, 2014).

In many ways this research enterprise has proved unusually successful. We now know divergent thinking contributes to the success of peoples' creative problem-solving efforts (e.g., Silvia, Martin, & Nusbaum, 2009). In addition to divergent thinking ability, we know that people need intelligence and expertise to solve creative problems (e.g., Vincent, Decker, & Mumford, 2002). We also know that to solve creative problems, people need to be able to execute a complex set of cognitive processing activities – activities such as problem definition, (Reiter-Palmon & Robinson, 2009), conceptual combination (Ward, Patterson, & Sifonis, 2004), and idea evaluation (Lonergan, Scott, & Mumford, 2004). Moreover, we have identified the conditions that allow effective execution of these cognitive processes: perceptions of psychological safety (Kark & Carmeli, 2009), feelings of creative self-efficacy (Tierney & Farmer, 2002), professionally challenging missions (Hunter, Bedell, & Mumford, 2007), and adequate resources (Nohari & Gulati, 1996), The aforementioned work has done much to enhance our understanding of creative problem-solving. Nonetheless, a key assumption underlies much of this work. Specifically, in most studies the intent has been to identify the capacities and conditions that *contribute* to creative problem-solving. Recently, however, Mumford, Martin, Elliott, & McIntosh (in press) have argued it may be just as important to understand the variables that lead to failure in creative problem-solving efforts. This argument was based on two key propositions: First, the variables that lead to failure in creative problem-solving efforts may at times be unique, representing something more, and something different – different from simply poor performance on the attributes contributing to success in creative problem-solving. Second, an understanding of the variables contributing to creative problem-solving failure might lead to identification of new interventions contributing to peoples' ability to solve creative problems. With these points in mind, our intent in the present study was to examine the impact of cognitive decision biases on creative problem-solving, and to assess the value of improving peoples' forecasting skills as a means for offsetting these biases.

Biases and Creative Problem-solving

The term "bias" typically refers to attributes that led to suboptimal performance on decision-making tasks, where optimal performance was defined based on a mathematical model (Hogarth, 1980). Prior research has identified a number of biases that result in suboptimal performance on a variety of decision tasks –typically relatively simple laboratory decision tasks (Kahneman & Tversky, 1979). For example, in making decisions, people have been shown to evidence suboptimal performance due to several common, simple biases: 1) illusory correlation (seeing the variables as correlated when they are not) (Chapman & Chapman, 1969), 2) chance availability of particular cases (focusing on cases that may not be relevant to the decision task at hand) (Maier, 1931), 3) over optimism with respect to the attainment of ouctomes (Josephs & Hahn, 1995), 4) illusions of control over outcomes even if actual outcomes are random (Langer, 1975), 5) anchoring (failure to adjust initial estimates sufficiently to take into account the present setting of the decision) (Tversky, 1973), and 6) risk minimization (biasing decisions to avoid risk rather than optimize gains) (Tversky & Kahneman, 2000). It is important to note that this list is not exhaustive: with great regularity, laboratory investigations lead to the identification of new decision biases for various experimental tasks (Hogarth, 1980).

Schoemaker (2004), however, notes that other biases may influence decision-making as the task becomes more complex. Indeed, many managerial decision tasks are highly complex, resulting in different biases influencing performance. For example, Van Dijk, Van Putten, and Zeelenberg (2007) have shown complex, real-world decisions may prove suboptimal as a result of peoples' efforts to protect prior investments (sunk costs). Teele (1980) has argued errors may arise when people make decisions in complex systems because decisions are treated as isolated events, despite the compex interactions that characterize most complex systems. Buehler, Griffin, and Ross (1994) have found that peoples' suboptimal decisions with respect to task completion times were often based on use of idealized models (or cases) where performance suffered due to obstacles encountered that were not given adequate attention.

Clearly both simple and complex decision biases exist. Now the question becomes: how might biases influence creative problem-solving? Traditionally, bias in creative problem-solving has been studied with respect to idea evaluation. Idea evaluation is one of the eight key processes involved in creative problem-solving which includes: 1) problem definition, 2) information gathering, 3) concept/case selection, 4) conceptual combination/reorganization, 5) idea generation, 6) idea evaluation, 7) implementation planning, and 8) monitoring (Mumford, Mobley, Reiter-Palmon, Uhlman, & Doares, 1991; Mumford, Medeiros, & Partlow, 2012). Idea evaluation is an active, constructive process where people appraise multiple ideas and seek the best idea(s) to be persued (Lonergan, Scott, & Mumford, 2004). Ideas are also manipulated and revised as they are considered for implementation. Based on the selection and revision aspects of idea evaluation, it is the creative problem-solving process most amenable to studying bias in creative thought.

In one study examining idea evaluation, Blair and Mumford (2007) asked 210 undergraduates to assume the role of members of a foundation's outreach program and generate 15 to 20 ideas that would lead the outreach program to be more effective. A panel of judges appraised these ideas for various attributes such as originality, ease of implementation, and risk. Subsequently, a second sample of 165 undergraduates were asked to assume the role of review board members and appraise 72 pairs of potential ideas for funding. For each pair of ideas, participants were to select their preferred idea. It was found that people disregarded original, risky, and time-consuming ideas, despite instructions indicating the foundation sought viable new programs. Therefore, a bias against the uncertainty inherent in creative ideas was apparent in peoples' idea evaluation.

In another study of idea evaluation, Licuanan, Dailey, and Mumford (2007) examined whether there was bias in peoples' evaluation of original ideas. In this study, 181 undergraduates were asked to assume the role of a marketing manager evaluating the ideas provided by six different teams, where the ideas provided by these teams varied in originality. Manipulations were induced to encourage active analysis of idea originality and the interactional process of each team. It was found that active analysis of idea originality and team interactions led people to select more original ideas. These findings suggest that without active processing, bias against original ideas in idea evaluation arises from a failure to understand or recognize idea originality.

The Blair et al. (2007) and Licuanan et al. (2007) studies provide evidence of bias in the execution of the idea evaluation process. However, it should be recognized that these studies have focused on only one of eight key processing activities (e.g., problem definition, conceptual combination) involved in creative thought. Although there are few studies explicitly examining the impact of bias on creativity, there is indirect evidence suggesting that other creative thinking processes might be subject to bias. For example, in problem definition, people prefer to define problems with respect to goals, although creative performance is improved when people define problems with respect to solution procedures and restrictions (Mumford, Baughman, Threlfall, Supinski, & Costanza, 1996). Similarly, in conceptual combination, people bias creative problem solutions (e.g., drawing aliens) to extant mental models (e.g., the bilateral structure of life on earth) (Finke, Ward, & Smith, 1992). These observations are noteworthy in their own right, while also pointing out that the overall impact of the operation of multiple alternative biases on creativity has not been examined.

Examining the overall impact of various biases on performance in creative problem-solving is noteworthy for another reason. The existence and operation of biases might be explained by a number of factors, including an individual's self-protection and risk minimization. However, the operation of decision biases is most commonly explained by peoples' application of heuristics that often reduce the cognitive demands made on people in decision-making (Keren & Teigen, 2004). Heuristics here are defined as strategies that are non-exhaustive in search, and that act as simplification strategies. Although the use of simplification strategies can have a negative impact, Gigerenzer and Gaissmaier (2011) and Hogarth (1980) remind us that use of these heuristics may at times prove beneficial for both long-term performance and adaptability. As a result, it is open to question when and why biases – either laboratory specific or global, real-world biases – actually act to diminish performance on creative problem-solving tasks.

An initial, theoretical answer to this question has been provided in an analysis of errors in creative thought provided by Mumford and colleagues (Mumford, Blair, Dailey, Leritz, & Osburn, 2006). They argue that biases and errors in creative problem-solving arise from the use of certain heuristics. Generally, the heuristics giving rise to these biases are simplification heuristics likely to result in maximal payoff to the individual with minimal investment of cognitive resources. As noted earlier, however, the kind of problems that call for creative thought are novel, complex, and ill-defined or poorly structured. And, to solve these kinds of problems, a substantial investment of cognitive resources is required. As a result, one would expect that biases, due to the use of simplified action heuristics, would lead to diminished performance on creative problem-solving tasks – both the kind of simple biases identified in laboratory studies and the more complex biases identified in studies of real-world decision-making. These observations led to our first two hypotheses:

Hypothesis one: People who evidence the biases identified in laboratory studies of decision-making (simple biases) will in solving creative problems produce solutions of lower originality, quality, and elegance.

Hypothesis two: People who evidence the biases identified in real-world studies of decision-making (complex biases) will in solving creative problems produce solutions of lower originality, quality, and elegance.

Forecasting

Our foregoing observations not only point to the impact biases may have on creative problem-solving, but also beg the question: how may we reduce the negative impact of biases on creative problem-solving? An initial answer we propose to this question is a forecasting intervention. Specifically, interventions that encourage people to invest cognitive resources in creative problems may serve to offset the operation of these biases and thus result in the production of more creative problem solutions. Therefore, if the complexity of the problem is anticipated, or the problem is one that engages the person’s professional interests (Hunter, Bedell, & Mumford, 2007), these biases may be less likely to operate, and performance in creative problem-solving will improve.

A key activity that may lead people to invest greater cognitive resrouces in creative problem-solving is forecasting. Forecasting relates to the projection of the downstream consequences of actions or ideas, and it has been found to influence the quality of peoples' performance in multiple domains, including leader problem-solving (Mumford, Steele, McIntosh, & Mulhearn, 2015) and ethical decision-making (Stenmark, Antes, Wang, Caughron, Thiel, & Mumford, 2010). Forecasting has also been found to influence the success of peoples' creative problem-solving efforts.

In a study examining forecasting, Byrne, Shipman, and Mumford (2010) asked 141 undergraduates to assume the role of a middle manager responsible for producing an advertising campaign for a new high-energy root beer. Participants were required to produce a written campaign proposal which was evaluated by judges for quality, originality, and elegance. Prior to preparing their proposals, participants received "emails" from their putative supervisor who asked them to 1) forecast the implications of their ideas and 2) forecast the effects of their plan for implementing the ideas they would pursue. Following the experiment, participants' written forecasts were appraised by judges for the extent to which they anticipated 27 attributes. These attributes included the number of positive outcomes forecasted, the number of negative outcomes forecasted, and the extent to which emergent opportunities, obstacles, and changes in resources were anticipated. Factoring of these ratings yielded two dimensions: the extensiveness of forecasts and forecasting negative outcomes. Both forecasting extensiveness and forecasting negative outcomes were found to result in the production of advertising campaigns of greater originality, higher quality, and greater elegance.

In a related study, Shipman, Byrne, and Mumford (2010) asked 252 undergraduates to assume the role of principal of a new, experimental secondary school and to formulate a written plan for leading the school. These plans were rated by judges for quality, originality, and elegance. As they worked on their plans, participants received “emails” from a consulting firm hired to help them formulate their plan. These emails asked participants to forecast various outcomes of their plan if acted on. Participants’ written forecasts were again evaluated by judges with respect to the extent to which they evidenced 27 attributes examined in the Byrne, Shipman, and Mumford (2010) study. A subsequent factoring yielded four dimensions: 1) forecasting extensiveness, 2) forecasting negative outcomes, 3) forecasting over a longer timeframe, and 4) forecasting resource availability. The extensiveness of peoples’ forecasts and forecasting over a longer timeframe were positively related with production of more original, higher quality, and more elegant solutions to this creative problem. In addition, it is of particular note that these forecasting attributes produced stronger relationships with creative performance than either intelligence of divergent thinking measures.

Not only does forecasting appear to contribute to creative problem-solving, it appears peoples’ forecasting improves when they are given appropriate instruction. For example, Osburn and Mumford (2006) asked 174 undergraduates to complete a set of seven self-paced training modules in which they were provided with strategies held to result in better forecasting. Some strategies included: forecast negative outcomes, forecast contingînces and restrictions, and forecast long-term outcomes. Subsequently, participants were asked to produce plans for leading a new, experimental secondary school. Judges appraised these plans for originality, quality, and elegance. It was found that training in forecasting resulted in the production of more creative problem solutions, and this effect was even stronger for talented partcipants (participants with strong divergent thinking skill). Based on these findings, we propose our third hypothesis:

Hypothesis three: Training in strategies for more effective forecasting will result in peoples' production of creative problem solutions of greater originality, quality, and elegance.

As discussed above, effective forecasting may directly affect peoples' creative problem-solving by encouraging more extensive elaboration of initial ideas (Mumford, Steele, McIntosh, & Mulhearn, 2015). However, forecasting may have another effect with respect to biases. Certain attributes of forecasting, especially the extensiveness of forecasts and forecasts over a longer timeframe, require people to think in greater depth and analyze the strengths and weaknesses of their ideas. Therefore, this active cognitive investment in creative problem-solving should make it less likely that people will apply simplification heuristics. As a result, one would expect that training people in viable strategies for forecasting would serve not only to improve the originality, quality, and elegance of solutions, but would also serve to reduce the negative effects of biases on peoples' creative problem-solving activities. Thus, forecasting training may reduce biases, resulting in the production of creative problem solutions of greater originality, quality, and elegance. This observation led to our next hypothesis:

Hypothesis four: Forecasting training will reduce biases that act to inhibit production of original, high quality, and elegant solutions to creative problems.

Considering the impact of biases on creativity, however, it is important to bear in mind that not all biases are equivalent. The simple biases (the biases identified in many laboratory studies examining simple decision tasks), such as illusory correlation, are often biases that emerge automatically with the activation of certain knowledge structures (Keren & Teigen, 2004). More complex biases (the biases identified in field studies examining complex decision tasks), such as sunk cost bias, are tied more to how people understand and analyze features of the problem at hand. Forecasting training may have little effect on simple biases, as they are activated automatically as knowledge is brought to bear on problems. In contrast, more complex biases arising from analysis of the problem may become less powerful influences on performance when forecasting training is provided because forecasting leads to more extensive analysis of potential solutions. Thus, we propose our fifth hypothesis:

> Hypothesis five: Forecasting training will reduce complex analytical biases influencing creative problem-solving, but not simple, automatically activated biases.

Method

Sample

The sample used to test these hypotheses consisted of 227 undergraduates, 84 men and 143 women, attending a large southwestern university. Participants were recruited from undergraduate psychology classes providing extra-credit for participation in experimental studies. Those seeking extra-credit reviewed a brief, one paragraph description of all studies currently seeking partcipants. This study was purported as one examining complex problem-solving. Based on this information, they selected the study in which they wished to participate. Those who agreed to participate in the present study had an average age of 19 years and an average work experience of 2 years. Participants' average grade point average was 3.6, with an average ACT score of 26.3.

General Procedure

The study duration was approximately three and a half hours. During the first 30 minutes, participants completed a set of timed covariate control measures. During the next hour, they were asked to complete a set of self-paced training modules. These training modules provided people with strategies intended to encourage 1) more extensive forecasting, 2) forecasting over a longer timeframe, 3) more extensive forecasting and forecasting over a longer timeframe, or 4) no instruction in forecasting strategies was provided.

After participants had worked through these self-paced instructional modules, they worked on the performance task over the course of the next hour. This performance task was a low-fidelity exercise where participants were asked to assume the role of a principal leading a new experimental secondary school. Their task was to provide a written plan describing and justifying the key actions they would take to ensure the success of the school. These written plans were appraised by judges for originality, quality, and elegance. The material provided in these written plans was also used by judges to appraise whether a number of simple and complex decision biases were evident in participants' planning activities. Once participants had completed their plans for leading this experimental secondary school, they were asked to complete a battery of untimed covariate control measures.

Covariate Controls

Given the findings of Vincent, Decker, and Mumford (2002), the first set of control measures employed were intended to take into account the effects of intelligence, divergent thinking, and expertise on creative problem-solving. To measure intelligence, the verbal reasoning measure in the Employee Aptitude Survey (EAS) was used. This 30-item measure presents a set of facts relative to a problem. People are asked to indicate whether a subsequent answer is true, false, or unknown given these facts. This measure yields retest reliabilities above .80. Evidence demonstrating the validity of this measure has been provided by Grimsley, Ruch, Warren, and Ford (1985) and Ruch and Ruch (1963).

Given the nature of the creative problem-solving task, Merrifield, Guilford, Christensen, and Frick's (1962) Consequences measure, a measure of divergent thinking, was used. This measure asks people to generate ideas reflecting the outcomes of unlikely events such as "what would be the consequences if people no longer wanted or needed sleep?" People are asked to list as many consequences they can think of for five such events in 10 minutes. When scored for fluency (the number of consequecnes generated), the measure yields internal consistency coefficients above .70. Merrifield et al. (1962) and Vincent, Decker, and Mumford (2002) have provided evidence for the construct and predictive validity of the measure.

To measure expertise relevant to the experimental task, in this case educational expertise, a background data measure developed by Scott, Lonergan, and Mumford (2005) was used (Mumford, Barrett, & Hester, 2012). In this measure, people are presented with 10 questions related to their exposure to and interest in educational issues. For example, people are asked “how often have you thought about educational issues (e.g., public schools, teachers, salary, etc.)?” or “how much time have you spent thinking about how to make schools better?” This measure produces internal consistency coefficicents above .70. Robledo, Hester, Peterson, Barrett, Day, Hougen, and Mumford (2012) and Scott, Lonergan, and Mumford (2005) have provided evidence for the validity of this measure of educational expertise.

Due to the planning component of the creative problem-solving task, participants were asked to complete a measure of planning skills. This measure, developed by Marta, Leritz, and Mumford (2005), provides scales intended to measure 1) identification of key causes, 2) identification of restrictions, 3) identificaiton of downstream consequences of actions, 4) use of opportunistic implementation strategies, and 5) environmental scanning. To measure these skills, people are presented with six scenarios drawn from the management literature. Following each scenario, people are asked five to six questions pertaining to the planning skills. These questions are followed by a set of eight to twelve response options that reflect more of less effective application of the planning skills under consideration. People are asked to select their two to three preferred responses and the measure is scored for the number of effective options selected. The measure yields a split-half reliability in the low .80s. Evidence bearing on the construct and predictive validity of the measure has been provided by Marta, Leritz, and Mumford (2005) and Osburn and Mumford (2006).

Because problem-solving also depends on deep, analytical thought, participants were asked to complete a measure of numeracy. The traditional paper and pencil format of the Berlin Numeracy Test, developed by Cokely, Galesic, Schulz, Ghazal, and

Garcia-Retamero (2012), was used. This measure assesses numeracy by asking people to answer four open-ended questions such as “Imagine we are throwing a five-sided die 50 times. On average, out of these 50 throws how many times would this five-sided die show an odd number (1, 3 or 5)? ________ out of 50 throws.” Evidence of both convergent and discriminant validity, as well as predictive validity, has been provided: the measure correlates highly with other numeracy and cognitive ability tests (r = .53 with Raven’s Advanced Matrices), does not correlate with unrelated constructs (r = .03 with motivation measures), and is a significant single predictor of peoples’ understanding of everyday risks (standardized beta coefficient of .34). The measure has also shown high levels of test-retest reliability, with reliabilities in the .90s.

Performance in solving creative problems also requires motivation. In order to assess this, Petty, Cacioppo, and Kao’s (1984) Need for Cognition scale was used. This 18-item self-report scale asks people to describe, using a 5-point agreement scale, behavior with respect to intellectually challenging tasks. For example, one item people are asked to appraise states “the notion of abstract thinking is appealing to me.” This scales yields internal consistency coefficients in the .80s. Cacioppo and Petty (1982) have provided evidence for the construct validity of this measure.

The final covariate control measure participants were asked to complete provided a global assessment of relevant personality characteristics. Participants were asked to complete Gill and Hodgkinson’s (2007) five-factor model questionnaire, which provides scales measuring neuroticism, agreeableness, extraversion, conscientiousness, and openness. On the measure, people are presented with 100 adjectives – for example, kind, critical, artistic, etc. People are asked to rate, on a 9-point scale, how accurate these adjectives are in describing them. The resulting scales for measuring these five global personality characteristcs all yield internal consistency coefficients in excess of .80. Evidence pointing to the validity of the measure has been provided by Gill and Hodgkinson (2007) and Mumford, Hester, Robledo, Peterson, Day, Hougen, and Barrett (2012).

Experimental Task

The experimental task participants were asked to complete was drawn from earlier work on creative problem-solving by Mumford, Hester, Robledo, Peterson, Day, Hougen, and Barrett (2012) and Scott, Lonergan, and Mumford (2005). This creative problem-solving task was selected both based on its relevance to the undergraduate population's expertise and based on the availability of evidence pointing to its validity. On this task, participants were asked to assume the role of principal of a new experimental secondary school and formulate a plan for leading the school.

Prior to preparing their plans, particiapnts read a page and a half of background material. This material noted the experimental secondary school had been established as part of a federal initiative intended to improve academic performance in secondary schools through development of new, novel, educational programs. It was also noted that experimantel schools in all fifty states would be compared to each other on a set of standardized tests assessing writing skills, reading comprehension, mathematics, analyses, and knowledge of social studies, geography, and foreign languages. Based on scores on these measures, successful schools would receive additional funding.

The school was described as being in a state characterized by poor performance on standardized tests. The school's population was 400 students from varied ethnic backgrounds. There was to be a 20:1 student-faculty ratio, with teachers receiving above average salaries as a result of their participation in the program. It was noted that instructional programs should serve the needs of a diverse student body – both the disabled and the gifted – as well as the typical students. Appendix B provides a description of the task.

After reading through the background material, participants were asked to generate a plan for leading the school. Participants were told that this plan should consider multiple elements such as teaching strategies, process improvement ideas, and school activities or programs. These written plans were to be two to three pages in length. The resulting plans provided a basis for assessing creative problem-solving, as well as biases evident in participants' creative problem-solving efforts.

Manipulations

Criticality

Criticality was manipulated as high or low in order to assess whether the stakes of the situation would impact creative problem-solving and/or the presence of biases. The criticality manipulation was imposed in the description of the experimental secondary school. In the high criticality condition, it was noted that 1) poor performing experimental schools would receive cuts in funding in subsequent years, 2) poor performing schools would be actively monitored by the federal government who might decide to shut-down the school, and 3) performance of secondary schools in the state was especially poor, ranked 47th, nationally with poor funding, ranked 49th nationally.

In the low criticality condition, potential negative outcomes or conditions of performance were minimized. Thus it was *not* noted in the background material that 1) poorly performing schools might receive budget cuts and 2) poor performing schools would be monitored by the federal government and might be shut-down. In addition, it was noted performance of secondary schools in the state was poor, ranked 37th nationally, with funding being ranked at 40th, but not exceptionally problematic.

Forecasting

Prior studies by Byrne, Shipman, and Mumford (2010) and Shipman, Byrne, and Mumford (2010) have indicated performance on creative problem-solving tasks is positively influenced by the extensiveness of forecasting and forecasting over a longer timeframe. Accordingly, in the second manipulation participants were assigned to one of four conditions where they were provided with 1) training intended to encourage more extensive forecasting, 2) training intended to encourage forecasting over a longer timeframe, 3) training intended to encourage both more extensive forecasting *and* forecasting over a longer timeframe, or 4) no training. Training occurred prior to giving participants the experimental task.

The approach used to provide participants with instruction in forecasting extensiveness and forecasting timeframe was drawn from earlier work conducted by Marcy and Mumford (2007; 2010). In their training model, instruction is focused on strategies that would encourage participants to forecast more extensively or forecast over a longer timeframe. Instruction in application of these strategies is provided through a set of self-paced instructional modules. In each self-paced instructional module, participants are first provided with a definition of the strategy, a description of how it might contribute to real-world problem-solving, and an example of applying this strategy in a real-world case instruction. Next, they are asked to answer three to four multiple-choice questions pertaining to the application of this strategy, after which feedback is provided. After answering these questions, participants are provided with a one-paragraph long real-world case where application of the strategy would contribute to solving the problem presented in the case. Subsequently, they are asked to answer two to three questions bearing on application of this strategy in addressing the case at hand, after which feedback is provided. After participants have completed the instructional modules developed for all relevant strategies, they are presented with a more complex, novel, ill-defined case and are asked to indicate which strategies are evident in formulating solutions to the problems related to the case and how they were applied.

For the purpose of the present study, all material presented in the self-paced forecasting training modules was drawn from a variety of domains – work, school, public policy, hobbies, marketing, etc. Each module of instruction typically took participants 10 to 15 minutes to complete. The strategies trained to improve the extensiveness of participants' forecasting were 1) consider a variety of stakeholder groups, 2) consider how various stakeholder groups might react to different outcomes, 3) consider how potential actions might benefit or harm others, 4) consider what alternative actions might be required due to emergent contingencies, and 5) consider alternative situations comparable to the situation at hand. The strategies trained to improve the timeframe of forecasting included 1) consider how long it took for events to unfold in past efforts, 2) consider when it was opportune to take action in past efforts, 3) consider how alternative acitons might connect, or unfold, over time, 4) consider how constraints might emerge, or unfold, over time, and 5) consider gaps in your knowledge relevant to the timing of actions. Participants were asked to complete the training modules pertaining to forecasting extensiveness prior to working through the training modules pertaining to forecasting timeframe in the condition where they were asked to complete both the forecasting extensiveness and forecasting timeframe training modules.

Outcome Measures

Bias Measures

To identify potential bias measures, three psychologists familiar with the literature on complex and simple cognitive biases were asked to review the available literature in relation to the experimental task to identify biases that might arise in task performance. Complex biases were identified by considering the literature on naturalistic decision-making and complex, cognitive problem-solving (e.g., Klein, 2008; Mumford, Blair, Dailey, Leritz, & Osburn, 2006; Mumford, Schultz, & Van Doorn, 2001). Simple biases were identified by considering the literature on biases observed in performance on well-defined, experimental decision-making tasks (e.g., Baron, 1994a; Baron, 1994b; Hogarth, 1980; Kahneman & Frederick, 2005).

Biases which both have been found to exert relatively strong effects in prior studies and have been held to be relevant to the experimental task were identified. A consensus decision was then reached as to the seven complex and seven simple biases which should be examined in the present study. The seven complex biases included: 1) illusory superiority, 2) wishful thinking, 3) inappropriate attributions of success, 4) inappropriate assumptions about speed of outcome attainment, 5) misleading memories, 6) inappropriate self-interest, and 7) inappropriate assumptions about the number of methods applied in making decisions. The seven simple biases included 1) illusory correlation, 2) base rate fallacy, 3) non-linear extrapolation, 4) unstated assumptions, 5) internal coherence, 6) ‘best-guess’ strategy, and 7) discounting probability.

For each bias, 3 trained judges, who were doctoral students in psychology, rated on a 5-point scale the extent to which each bias was evident in participants’ plans. Each rating scale provided a concrete operational definition of the bias, along with an example statement illustrating how this bias would be evident in peoples’ written plans. For the purposes of the ratings, biases were defined as attributes that led to suboptimal performance on decision-making tasks, where optimal performance was defined based on a mathematical model (Hogarth, 1980).

Prior to making these ratings, judges were asked to complete a 5-hour training program. First, judges were familiarized with the general nature of simple and complex biases. Then, they were presented with a description of each simple and complex decision bias and how these biases might act to influence performance on various problem-solving tasks. Next, judges were asked to apply the rating scales to evaluate the biases evident in a set of plans for addressing the experimental secondary school problem. After judges made these ratings, they met as a panel and discussed and resolved discrepancies in their ratings. Following this instruction and practice, the average inter-judge agreement coefficients obtained for evaluations of the simple biases was .85, and the average inter-judge agreement coefficient obtained for evaluations of the complex biases was .86. Examination of the correlations among these bias ratings provided evidence for their construct validity. For example, for the complex biases wishful thinking was found to be positively related to illusory superiority (r = .32). For the simple biases, unstated assumptions was found to be positively related to non-linear extrapolation (r = .26).

Creative Problem-solving

Prior research has indicated that creative problem solutions are characterized by three dimensions: high quality, originality, and elegance (Besemer & O'Quin, 1998; Christaans, 2002). Accordingly, to assess performance on the creative problem-solving task, a panel of 3 judges, all doctoral students in psychology familiar with the educational and creativity literature, were asked to rate on a 5-point scale the quality, originality, and elegance of the written plans. Quality was defined as a complete, coherent, potentially useful plan. Originality was defined as an unexpected and surprising plan. Elegance was defined as a plan where parts flowed well together in a clear, refined way.

Based on the findings of Redmond, Mumford, and Teach (1993), these ratings were to be made with respect to a set of benchmark rating scales. On these benchmark scales, appraisals of plan quality, originality, and elegance were to be made with respect to illustrations of these attributes as reflected in educational plans provided by undergraduates. To develop these benchmark rating scales, a sample of 40 plans was obtained and a panel of judges rated these plans for quality, originality, and elegance on a 5-point scale. Subsequently, plans evidencing high and low levels of quality, originality, and elegance where judges evidenced good agreement and low standard deviations in their appraisals were identified. These plans were then extracted and used to provide scale anchors. Appendix C provides the quality, originality, and elegance rating scales appearing in the present study.

Prior to making ratings, judges were asked to participate in a 5-hour training program. In this training program, judges were familiarized with the nature of the secondary school planning task, along with the definitions of plan quality, originality, and elegance to be employed. Judges were then presented with the behavioral rating scales for appraising quality, originality, and elegance, and they were asked to apply these rating scales in appraising a set of educational plans. After making these ratings, judges met to discuss and resolve any discrepancies in their ratings.

Following training, the inter-judge agreement coefficients obtained for evaluations of plan quality, originality, and elegance were .82, .82, and .82, respectively. Examination of the correlations of these ratings with the covariate control measures also provided some evidence for their construct validity. Thus divergent thinking was found to be positively related to ratings of solution originality ($r = .28$) and solution quality ($r = .26$). Ratings of elegance were found to be positively related to openness ($r = .16$) and conscientiousness ($r = .10$).

Analyses

Scores on the complex and simple bias rating scales were first averaged to provide an overall index of the presence of biases in participants' creative problem solutions. Subsequently, evaluations of solution quality, originality, and elegance were regressed on the complex and simple biases averaged after first taking into account the effects of the relevant covariate controls. Following these initial regression analyses, a series of analyses of covariance tests were conducted where the effects of the criticality and forecasting training manipulations on simple and complex biases, as well as the effects of the manipulations on the quality, originality, and elegance of solutions, were assessed.

Results

Correlations and Regressions

Examining the average scores of the prevalence of simple and complex biases, it was found that biases in problem solutions were negatively related to creative problem-solving. More specifically, the prevalence of simple biases was found to be negatively related to production of more original ($r = -.09$), higher quality ($r = -.26$), and more elegant ($r = -.11$) solutions on the creative problem-solving task. Similarly, the prevalence of complex biases was found to be negatively related to the production of more original ($r = -.41$), higher quality ($r = -.41$), and more elegant ($r = -.49$) solutions on the creative problem-solving task. Thus, cognitive biases, either simple or complex, seem to undermine peoples' performance on creative problem-solving tasks. However, these results suggest that more complex, as opposed to simple, decision biases exert much stronger negative effects on peoples' performance when solving creative problems.

Some support for this observation was also provided by the results from the regression analyses. Table one presents the results obtained when solution originality, quality, and elegance ratings were regressed on the prevalence of simple and complex biases after taking into account the various covariate controls. For solution originality, the covariate controls produced a multiple correlation of .37 when used to account for solution originality. When the simple and complex biases where added to the covariate controls, the multiple correlation increased to .52, with the complex biases ($\beta = -.37$)

producing a larger regression weight than the simple biases (β = -.10). In accounting for solution quality, the covariate controls produced a multiple correlation of .32, which increased to .54 when the simple and complex biases were added. Again, the complex biases (β = -.36) produced a larger regression weight than the simple biases (β = -.27). When elegance was regressed on the covariate controls, a multiple correlation of .21 was obtained, which increased to .53 when the simple and complex biases were added. The compex biases (β = -.48) again yielded a larger regression weight than the simple biases (β = -.10). Therefore, the complex biases appear to have stronger effects on the originality, quality, and elegance of creative problem solutions than the simple biases.

Bias Effects

Table two presents the results from the analysis of covariance when the experimental manipulations were used to account for the presence of complex and simple biases in creative problem-solving. In accounting for complex biases, need for cognition (F, 1, 225), 8.26, $p < .01$) and planning (F, 1, 225), 5.58, $p < .05$) were both negatively related to the expression of complex biases. These findings indicate that investment of cognitive resources reduces complex biases in creative problem-solving. More centrally, a significant main effect (F, 3, 223), 2.66, $p < .05$) was obtained for training in forecasting strategies on complex biases. Inspection of the cell means indicated that complex biases were increased by training both extensiveness and timeframe strategies (m = 1.83, *SE* = .034) and training timeframe strategies (m = 1.86, *SE* = .035) when compared to providing training in extensiveness strategies (m = 1.74, *SE* = .034) or no training (m = 1.73, *SE* = 034). These findings suggest certain types of forecasting training, due to use of unfamiliar strategies, may have led to participants evidencing more complex biases.

The analysis of covariance results obtained when the experimental manipulations were used to account for the occurrence of simple biases are also presented in table two. The only significant covariate was conscientiousness (F, 1, 225), 4.61, $p < .05$), with more conscientious people evidencing fewer simple decision biases. A marginally significant main effect (F, 3, 223), 2.32, $p < .10$) was also obtained for training in forecasting strategies. It was found that training both extensiveness and timeframe ($m = 1.41$, $SE = .035$) resulted in more simple biases being evident in peoples' plans as compared to training only extensiveness strategies ($m = 1.29$, $SE = .034$), training only timeframe strategies ($m = 1.34$, $SE = .035$), or no training ($m = 1.31$, $SE = .034$). Apparently, training both extensiveness and timeframe forecasting strategies, perhaps due to fatigue effects, led to more evidence of biases in peoples' plans.

Creative Problem-solving

Given the impact of these biases on the production of original, high quality, and elegant solutions, a new question arises: does forecasting training result in the production of more original, high quality, and more elegant solutions to creative problems? Table three presents the results obtained in the analysis of covariance intended to provide an initial answer to this question.

In accounting for the production of more original solutions, divergent thinking (F, 1, 225), 17.80, $p < .01$), need for cognition (F, 1, 225), 5.15, $p < .05$), and planning (F, 1, 225), 6.76, $p < .05$) were found to be significant covariates. Unsurprisingly, divergent thinking and need for cognition were both positively related to production of more original solutions to creative problems. A marginally significant (F, 3, 223), 2.41, $p < .10$) relationship was also obtained in examining the effects of forecasting training on solution originality. Inspection of the cell means indicated that training both extensiveness and timeframe strategies ($m = 2.80$, $SE = .10$) and training only extensiveness ($m = 2.97$, $SE = .099$) and timeframe ($m = 2.73$, $SE = .11$) strategies resulted in production of somewhat less original solutions than no training ($m = 3.15$, $SE = .12$) in forecasting strategies. Therefore, forecasting training may harm production of original solutions to creative problems.

When the impact of training in forecasting strategies on the quality of solutions to creative problems was examined, a different pattern of effects emerged. Again, divergent thinking (F, 1, 225), 16.58, $p < .01$) and need for cognition (F, 1, 225), 4.46, $p < .05$), along with planning skills (F, 1, 225), 5.71, $p < .05$), were found to be significant covariates positively related to the production of higher quality solutions. Therefore, people who can generate ideas, think about those ideas, and plan idea execution produce solutions of higher quality to problems calling for creative thought.

More centrally, a significant (F, 3, 223), 3.29, $p < .05$) main effect was obtained for forecasting training with respect to solution quality. In examining the cell means, it was found that those receiving training in both extensiveness and timeframe strategies ($m = 3.01$, $SE = .10$), as well as just training in extensiveness ($m = 2.97$, $SE = .01$) and timeframe ($m = 2.81$, $SE = .11$) strategies produced higher quality solutions than those who received no training ($m = 2.58$, $SE = .11$).

With respect to the elegance of solutions provided for creative problems, only a single covariate, openness, produced a significant (F, 1, 225), 5.38, $p < .05$) effect. Thus it was found that openness was positively related to production of more elegant solutions to problems calling for creative solutions. However, neither the forecasting training nor the criticality manipulation had significant effects of solution elegance.

Discussion

Before addressing the conclusions from the present study, certain limitations should be noted. First, it should be recognized that the present study was based on a low fidelity simulation method where participants were asked to solve an educational planning problem known to call for creative thought (Motowidlo, Dunnette, & Carter, 1990). Although evidence suggests that the creative problem-solving task used in the present study was appropriate for the sample, the question remains as to whether or not the same findings would emerge in creative problem-solving tasks drawn from different domains (Baer, 2010; Scott, Lonergan, & Mumford, 2005). Additionally, it remains open to question whether similar findings would be obtained if experts in education had been studied in a more naturalistic setting (Ericsson, 2009).

Another potential limitation is that forecasting was examined by training certain strategies. The extensiveness and timeframe strategies which provided the basis for instruction in the present effort (e.g., forecasting the effects of actions on a set of stakeholders, forecasting continginces that might emerge over time) did seem appropriate given what we know about forecasting at this point (Mumford, Steele, McIntosh, & Mulhearn, 2015). However, a number of strategies, potentially strategies exhibiting stronger and different effects, may be involved in forecasting. And, clearly, the present effort cannot speak to these other, unexamined forecasting strategies.

It should also be recognized that in the present study the effects of forecasting training were “bundled.” By the term bundled it is meant that we have examined multiple strategies held to contribute to either forecasting extensiveness or forecasting timeframe. Although prior studies indicate forecasting extensiveness and forecasting timeframe are two central variables influencing complex, creative problem-solving (Byrne, Shipman, & Mumford, 2010; Shipman, Byrne, & Mumford, 2010), the present study cannot provide any evidence pertaining to the relative strength or importance of one forecasting extensive strategy, or one forecasting timeframe strategy, over another.

With regard to strategy training, it should also be recognized that training in these strategies was based on a self-paced, rather abbreviated instructional program. Although this instructional approach has proven effective for strategy-based training in studies of causal analysis skills (Marcy & Mumford, 2007; 2010), it is not the only, or necessarily the most effective, instructional approach for encouraging the use of various strategies in forecasting. It should also be recognized that the forecasting extensiveness and timeframe modules were provided in a fixed order. Of course, forecasting instruction in a fixed order eliminates potential confounding. Because of this fixed order, the present study cannot speak to the effects of presenting forecasting instructions for extensiveness and timeframe in a different order. The fixed design in the present study, however, did allow us to isolate the unique effects of extensiveness and timeframe instruction.

A final limitation relates to the present study's identification of biases. Prior studies of biases have typically employed one of two methods. In one method, a given bias is isolated through experimental studies relative to a departure from mathematically optimal decisions (e.g., Kahneman & Tversky, 1979). In the other method, ratings of real-world, real-time decisions are used to infer potential decision biases (e.g., Klein, 2008). In the present study, however, trained judges were asked to evaluate the prevalence of biases by examining actual work products. Although these ratings were reliable, and evidenced some construct validity, caution is called for whenever a new methodological approach is employed.

Even bearing these caveats in mind, we believe the results obtained in the present study have noteworthy implications. As Mumford, Martin, Elliott, and McIntosh (in review) have pointed out, little has been said about why people fail at creative problem-solving – although some studies have examined errors and biases in idea evaluation (e.g., Blair & Mumford, 2007). Mumford, Blair, Dailey, Leritz, and Osburn (2006), however, have argued that errors in creative problem-solving may arise from various cognitive biases, and these biases may have a powerful negative impact on peoples' ability to produce original, quality, and elegant solutions to the novel, complex, ill-defined problems that call for creative thought.

These observations led to the first two hypotheses underlying the present effort. These hypotheses proposed that both the simple cognitive biases identified in laboratory studies and the complex biases identified in naturalistic studies would result in the production of creative problem solutions evidencing less originality, lower quality, and less elegance. In fact, the results obtained in the present study confirm these hypotheses.

When simple cognitive biases were evident in peoples' problem solutions, solutions of lower quality, originality, and elegance were obtained. When complex biases were evident in peoples' problem solutions, solutions of much lower quality, much lower originality, and much lower elegance were obtained. Put differently, the operation of cognitive biases impairs creative problem-solving.

It is important to note that complex biases appeared to exert much stronger negative effects on solution quality, originality, and elegance as compared to more simple cognitive biases. One explanation for the stronger effects of complex, as opposed to simple, biases on creative problem solutions has been provided by Gigerenzer and Gaissmaier (2011) and Hogarth (1980), who have argued that many of the simple cognitive biases identified in earlier studies of decision-making have some adaptive value. As a result of their potential adaptive value, simple decision biases may exert somewhat weaker effects on creative problem-solving in comparison to more complex biases.

Simple biases, however, still appear to negatively impact creative problem-solving. Mumford and Gustafson (2007) remind us creative problem solutions are a response to a central type of problem, specifically complex, novel, ill-defined problems. Biases evident in active, conscious, analysis of these types of problems – biases such as illusory superiority, wishful thinking, use of irrelevant experiences, or justification of a limited number of methods for appraising a problem – all may act to lead people down the wrong path, resulting in the production of creative problem solutions of lower originality, quality, and elegance. This may be in part due to a lack of effective investment of requisite cognitive resources and in part due to not effectively, fully evaluating ideas generated in solving creative problems (Gibson & Mumford, 2013; Lonergan, Scott, & Mumford, 2004).

Our fourth hypothesis held that these biases might be reduced by training people in more effective strategies for forecasting, while our fifth hypothesis held that by reducing bias, higher quality, more original, and more elegant solutions would emerge. Neither of these hypotheses found any support in the present investigation. In particular, we found that training in strategies contributing to both more extensive forecasting and forecasting over a longer timeframe always resulted in more biases being evident in problem solutions as compared to no training. These effects are likely due to fatigue given the number of self-paced training modules people were asked to complete. More specifically, when participants were trained on multiple heuristics, it makes sense that participants would try to simplify the complex information given to them, thereby increasing the prevalence of biases in their responses.

It should be recognized, however, that forecasting training did not always result in more bias being evident in problem solutions. In the case of complex biases, training in strategies intended to encourage more extensive forecasting per se did not result in performance decrements with respect to untrained controls. Similarly, for simple biases, training in strategies intended to encourage people to forecast over a longer timeframe did not result in diminished performance with respect to untrained controls. These findings are noteworthy because they suggest although forecasting may not reduce bias, training in forecasting may also not result in more biases being evident in problem-solving – at least when fatigue effects are not induced as a result of training too many strategies.

Based on prior research on forecasting, we hypothesized (hypothesis three) that training in strategies intended to encourage people to forecast more extensively or forecast over a longer timeframe would exert unique effects on the originality, quality, and elegance of peoples' creative problem solutions (Byrne, Shipman, & Mumford, 2010; Shipman, Byrne, & Mumford, 2010). In fact, with regard to the production of higher quality solutions, it was found that extensiveness training, timeframe training, and both extensiveness and timeframe training resulted in better solutions than no training in strategies contributing to forecasting. Therefore, training in strategies contributing to forecasting results in the production of higher quality solutions to problems calling for creative thought.

A potential explanation for this effect is implied by the finding that training in forecasting strategies resulted in somewhat poorer performance with respect to the production of original problem solutions. One explanation for this pattern of effects is that forecasting training does not help people generate original ideas. Rather, forecasting training allows people to explore the implications of potential ideas. And, the feedback and analysis resulting from this exploration, like feedback provided by others (Gibson & Mumford, 2013), allows people to craft creative problem solutions of greater quality.

In real-world settings, it is often not enough simply to have an original idea. Instead, it is as critical, perhaps more critical, if the solution to a problem calling for creative thought is of adequate quality. As a result, the findings obtained in the present investigation suggest that encouraging people to forecast the downstream implications of their ideas may represent one technique for improving the value or workability of creative ideas. Forecasting training may not reduce biases evident in creative problem solutions. However, training does help people elaborate and define their ideas in such a way that more viable, higher quality solutions to creative problems might emerge.

Future Directions

From this preliminary study of creativity, forecasting, and bias, it is apparent that biases impair creative problem-solving and that forecasting training may improve the quality of creative problem solutions. However, there are still many questions that remain regarding these constructs. For example, how does forecasting allow people to formulate high quality solutions to creative problems? Also, is there a threshold for biases, such that to an extent biases have no effect on performance, until a certain point where biases have a negative effect on creative problem-solving performance? Additionally, do some simple biases, or some complex biases, impact creative problem-solving performance more than others? Future research may also examine using different strategies to train forecasting. For example, training participants to forecast negative events or to forecast contingince and restrictions may evidence different results than the forecasting training used here that trained forecasting extensiveness and timeframe. Future research may also examine the use of different lengths of forecasting training, including both shorter training interventions and longer training interventions, to investigate the impact of training length on the prevalence of biases and creative problem-solving performance. Of course, there are many other research questions that may arise from the study of these constructs. We hope the present effort serves as an impetus to investigate these questions.

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Appendix A

Table 1. *Regression Results*

	Originality				Quality				Elegance			
	β	*SE*	*R*	Sig. of change	β	*SE*	*R*	Sig. of change	β	*SE*	*R*	Sig. of change
Block One Covariates			.37	-			.32	-			.21	-
Openness	.085	.002			.049	.002			.17*	.002		
Numeracy	.088	.05			.032	.045			.042	.048		
Planning	.077	.027			.11	.027			-.013	.028		
Divergent Thinking	.29**	.006			.24**	.006			.078	.006		
Need for Cognition	.037	.073			.041	.071			-.057	.076		
Conscientiousness	-.070	.003			-.017	.002			-.041	.003		
Block Two with Biases			.52	.00			.54	.00			.53	.00
Simple Biases	-.10	.18			-.27**	.17			-.10	.18		
Complex Biases	-.37**	.19			-.36**	.18			-.48**	.19		

Note. β indicates standardized regression weight, *SE* indicates standard error of regression weight, *R* indicates multiple correlation value, Sig. of change indicates significance of change. * $p < .05$. ** $p < .01$.

Table 2. *Effects of Manipulations on Simple and Complex Biases.*

	Simple Biases				Complex Biases			
	F	df	p	η^2	F	df	p	η^2
Significant Covariates								
Need for Cognition	-	-	-	-	8.26	1	.00	.037
Planning	-	-	-	-	5.58	1	.019	.025
Conscientiousness	4.61	1	.03	.021	-	-	-	-
Effects								
Criticality	.15	1	.70	.001	.41	1	.52	.002
Forecasting	2.32	3	.076	.031	2.66	3	.049	.035
Criticality*Forecasting	.70	3	.55	.009	.55	3	.65	.008

Note. F indicates F-ratio, df indicates degrees of freedom, p indicates significance level, $\eta 2$ indicates squared effect size estimate.

Table 3. *Effects of Manipulations on Originality, Quality, and Elegance.*

	Originality				Quality				Elegance			
	F	*df*	*p*	η^2	*F*	*df*	*p*	η^2	*F*	*df*	*p*	η^2
Significant Covariates												
Divergent Thinking	17.80	1	.00	.076	16.58	1	.00	.071	-	-	-	-
Need for Cognition	5.15	1	.02	.023	4.46	1	.036	.020	-	-	-	-
Planning	6.76	1	.01	.03	5.71	1	.018	.026				
Openness	-	-	-	-	-	-	-	-	5.38	1	.021	.024
Effects												
Criticality	.74	1	.39	.003	.023	1	.88	.00	.79	1	.38	.004
Forecasting	2.41	3	.068	.032	3.29	3	.022	.044	1.42	3	.24	.019
Criticality*Forecasting	.003	3	1.0	.00	.69	3	.56	.009	.42	3	.74	.006

Note. F indicates F-ratio, *df* indicates degrees of freedom, *p* indicates significance level, *η2* indicates squared effect size estimate.

Appendix B

Creative Problem-solving Task

The following information has been gathered from the state school board. It gives you details about "Oklahoma Excel" Secondary School. This information provides you with important knowledge you need to develop your own idea of how to run the school.

"Oklahoma Excel" Secondary School

You have been appointed as the Principal of the state's experimental school in Tulsa, OK called "Oklahoma Excel." The school is part of a national study to increase achievement in schools in the United States. Funding for the Oklahoma Excel School will be allotted in accordance with a federal grant distributed by the National Education Agency to each State Department of Education. Each state is awarded funding for one experiment school, and Tulsa's Oklahoma Excel School is Oklahoma's representation in the national study. The goal of each experimental states school is to develop and implement a new type of educational program that increases students' academic performance. At the end of the 2016-2017 school year, Oklahoma Excel will be evaluated in reference to the students of the other states' experimental schools as well as in relation to the students of traditional Oklahoma public schools.

Program Evaluation

This evaluation of the students in the experimental schools will be based on improvement of the students in the schools. Each student will take a pre-test over material selected by the National Education Agency at the beginning of the school year. This will assess the increases in academic performance for each experimental school. These tests will be administered in all of the experimental schools, and the improvement scores will be compared across students of all the states. The material on the test will be benchmarked by the National Standards of Education General Guidelines (for example, all students should read grade level).

The evaluation of Oklahoma Excel students compared to other students in Oklahoma will be based on scores of the Oklahoma Standardized Test. All students in Oklahoma are required to take this test, and the material covered on it is general. It assesses writing skills, reading comprehension, mathematic skills, and analytical skills. There are also subtests on sciences, social studies, geography and a foreign language component that assesses fluency. This test is essentially how Oklahoma Excel students are compared to students in traditional schools in Oklahoma.

After these comparisons to other states' experimental schools and other Oklahoma traditional public schools, the National Education Agency will rank the most successful states in terms of experimental school accomplishment. The states with the most successful experimental schools will receive additional federal funding for the next school year in order to spread the new curriculum around the state for comprehensive state scholastic improvement. The states with the least successful experimental schools (ranked 45th-50th) will face cuts in funding, particularly in the Administrative Department. Additionally, these low-ranking schools will be monitored and evaluated monthly by a member from the National Education Agency, and if the evaluations do not improve, the school will be shut-down.

Current Situation

Therefore, the Oklahoma State Board of Education is hopeful for dramatic improvements of students in your Oklahoma Excel School. You are feeling additional stress for success because last year students in Oklahoma Public Schools ranked 47^{th} nationally in academic performance on Standardized Tests. The state is also currently ranked 49^{th} in funding for education. With these poor rankings in mind, you know that the school has the potential to fail and ultimately be shut-down. Therefore, you are determined to make a successful plan that will improve Oklahoma Excel. Doing so would lead to exciting effects in Oklahoma and increase the state's national standing. Oklahoma Excel will be a secondary school with students of grades 9-12. You have a projected enrollment of 400 students from varied ethnic backgrounds (73% Caucasian, 13% Native American, 10% African American, 3% Hispanic, and 1% Other). Also, a principle concern of yours will be to make sure that your teaching method helps members of special populations, including gifted students and academically disabled students. Since the State Department of Education is so interested in Oklahoma Excel, it is willing to provide maximum support. This includes providing enough teachers for a 20:1 ratio of students to instructors. Also, they are willing to pay the teachers above average salaries. Because of these optimal teaching conditions, you will be able to recruit high-caliber instructors who are motivated to make your school a success. However, if your plan is not successful, funding will be cut, negatively influencing both your ability to hire exceptional teachers and your salary.

Your Task

Your ultimate goal as the Principal of Oklahoma Excel is to generate a plan to **"achieve academic excellence."** This plan should incorporate a number of elements including teaching strategies, process improvement ideas, special activities or programs, etc.

Appendix C

Benchmark Rating Scales for Quality, Originality, and Elegance

School Plan Ratings:

Decision Making

1. Quality

Definition: the overall quality of the participant's plan.

Things to look for:

- **Completeness:** Did the participant understand the critical issues? Did he/she address all of the most relevant information at hand?
- **Coherence:** Was the response coherent? Was it well thought out and logical?
- **Usefulness:** Is the response actually feasible and appropriate for addressing the problem?

Rating Scale

1 – Poor quality. The plan is haphazard and fragmented and does not address any of the key issues; it does not provide key information in a logical manner.

> The school's layout will be similar to OSSM. Except that the students are not required to live on campus. For each class a student takes e.g. Math, English, Science, History, Government, etc, there will be a mandatory meeting outside of the class, one day a week for study and discussion lasting an hour. No study on Wednesday because of church. This might seem like a big downer, so the teachers should make normal school hours more fun, and more interactive. This way students will look forward to fun ways of learning. Every game or activity should have a learning objective or strategy.
> Punishing mal behavior, and poor grades will be stricter in a sense, including stripping eligibility to participate in sports, organizations and other activities until grades are above D's not F's. Eligibility will be taken away not just at the end of periods such as, week, month or semester, but as soon as the grade is earned. School should also start an hour later. So at 9 instead of 8.

2 – Poor to average quality. A few key issues may be addressed; however, a clear plan is still not presented; key parts of the plan are unclear.

3 – Average quality. The plan is presented in a logical form; a number of key issues may still be missing or vague, but overall the plan addresses some of the major issues of the problem and is presented clearly and coherently.

The teaching strategy I would use would be the TAI model. TAI is the most complete strategy because it combines individual learning with group work. Since the students would be working in groups they would have greater motivational power because of it therefore try to work harder Since they also get to work individually they can work at their own sill level and work speed. I will have a program that evaluates the students on a bi-weekly basis to see their progress and make sure that they are effectively being taught. I would have an optional meeting time during the school day so that students can go work with their teachers on a more personal level so not only that they get help on the homework they have, they also begin to build a personal relationship with their teachers. Teaching strategy would be to motivate the students to do hard positive work all of the time. Students will work in motivated teams of 4-5 members and work at a pace that is most beneficial to their learning. The teams will switch members every month so that the students can get to know their fellow students. A placement test will be given to determine how groups are initially divided.

4 – Average to excellent quality. Many of the key issues are addressed in the plan and plan is feasible; however, some information may seem unimportant to the plan or is not completely thought out.

5 – Excellent quality. The plan is presented so that is exceptionally coherent and clear and addresses the key issues in a manner that is feasible.

1. Have both lectures and small groups in the classrooms.
2. Make sure that their will be tutoring hours set up for those students get that extra help they need (with the teachers getting paid more this shouldn't be too hard to get them to do)-also see if it would be possibly to make that tutoring mandatory for anyone who has below a certain grade point average in the class at any given time.
3. Read over the material for each grade level and have the teachers for that grade get together and decide how much time will be most efficient to spend on each subject matter (if it is a harder lesson=teach it and do more activities with it over a longer time period compared to that of a lesson not as hard.)
4. Make sure in the lessons you teach the slower students to where they understand the material but then make sure to go that little extra step at the end to further those students who learn fast.
5. See if it would be in the funding to start a program that would meet once a week for those students who are above the rest-yes you want to improve the lower ones but by furthering those that are smarter it will benefit the overall scores of the school too.
6. Like the Teams-Games-Tournament approach have a game tournament incorporating the material and switching up the teams but instead of doing this all the time…just do it once per lesson covered that way you still have time to get through all the material needed but can also get the students more involved, engaged and interested.
7. Of course keep assigning homework with each lesson and test the students over it because that is the main way to practice and get better familiarized with the information.

2. Originality

Definition: the extent to which the plan is original and creative.

Things to look for:

- **Unexpected:** Did the participant approach the problem in a novel, imaginative, unpredictable, or innovative manner?
- **Elaborative/Descriptive:** Did the participant provide a rich answer—one that helps the reader to visualize the solution for addressing the problem?

Rating Scale

1 – Poor originality. The plan is very predictable and is given in basic terms with no elaboration. The plan only uses bare ideas and is commonplace and ordinary.

> At the Oklahoma Excel School, I would like to implement large number of special programs to encourage each and every student to live up to his/her full potential. First of all, I believe a gifted/talented program is necessary to have at the school in order for the brighter students to excel. The program would meet as one to two regular class periods and will cover material more in-depth than regular classes. This will ensure higher learning at the school. Also, a special education program must be put into place at the school to ensure students do not fall behind in course material that is difficult.
>
> Students should have the option of either taking advanced or regular classes. It should be stressed that all classes will require outside work. Remedial classes should also be offered in case students fall significantly behind in a course. After school tutoring must be offered in <u>all</u> subjects.

2 – Poor to average originality. The plan presents ideas in a slightly unique manner. The plan mostly provides common ideas that do not reflect much elaboration or description.

3 – Average originality. The plan contains something that makes it different from the typical plan. The approach is original and contains some descriptive information. Description and elaboration are present but not entirely complete.

> My plan for the Oklahoma Excel School would be to create a higher level of learning. I would use different teaching methods to help improve the students desire to learn. I would make the classrooms more user-friendly with individual computers for each student. The teaching techniques would differ from the usual lecture and test method. The teachers would use methods such as the Team-Games-Tournament scenario and the Academic Controversy method. These two methods would help teach the students the curriculum as well as teach them everyday skills and help create better relations between different groups. I would have once-a-week team-assisted-individualization courses so the people who didn’t understand the could get help from fellow students, the team that improved the most would then have a chance to take a class period off to use as they wished on the campus. This would likely motivate the students and encourage them to help each other. The teachers would be able to offer more personalized help to the students by having better relationships with the students, when the teachers know what interests the students they can use that to help the students learn. The teachers would be held accountable for their teaching methods by weekly evaluations on improvement and involvement. The school’s main focus would be academic achievement, but there would also be student organizations and extra-curriculars that would be offered. Although students could only join if they had a certain GPA and had improved their test scores. Students would be offered free tutoring at their request. The tutoring could be individualized or it could be split into focus

groups such as abilities or disabilities working together to comprehend the material with methods that they understand.

4 – Average to excellent originality. The plan contains something that makes it different from the typical solution. The approach is original and contains some descriptive information. Description and elaboration are present but not entirely complete.

5 – Excellent originality. The plan is exceptionally unique. The participant includes characteristics or details that make the plan unique to him/her. The plan clearly reflects an unexpected understanding approach to the problem and goes beyond the norm and presents new ideas that are highly descriptive.

> The goal of this new plan is to ensure that these educations programs within Oklahoma are increasing. I believe that this starts with the teachers. Each teacher will be carefully selected based on their education, and most importantly their motivation. These will be teachers who aren't as interested in a paycheck as they are in progression of education. They will be teachers who appear impressionable and who can impact the students.
>
> Teachers will be required to spend one hour of personal assessment time with each student in his/her class once every quarter. Teachers will also be required to give an assessment tests over the particular curriculum weekly. The teaching style that will be applied in each classroom will involve teamwork, class competition, and lecture. At the beginning of a new chapter or section of curriculum the teacher will lecture over the topic. Students will be required to take notes and turn them in just to enforce the importance of studying and preparation of material for studying. Students will then be divided into 5 groups of 4 and prepare questions outlining the covered material. The students will be given 15 minutes. Next they will quiz each other (1 group to the other 4) to assess how much they learned of the unit. Tests will be given weekly covering the material. There will be a comprehensive test every quarter.

3. Elegance

Definition: the degree to which the participant's plan is articulately arranged in a succinct way.

Things to look for:

- **Flow**: Do all parts of the plan fit together smoothly? Does it flow seamlessly?
- **Refinement**: Is the plan easy to follow and well-refined? Is the plan focused well so that it uses the minimal number of elements to operate?
- **Clever**: Was the plan well-designed and cleverly put together?

Rating Scale

1 – Poor elegance. The plan lacks flow and focus. There are a number of ideas gathered together without order. Plan is very difficult to follow.

1. Promote higher achievement and increase the quality of problem solving, decision-making, critical thinking, reasoning, interpersonal relationships, and psychological health and well-being.
2. Facilitate academic achievement for students at every performance level.
3. Increase attendance, performance of students with academic disabilities, students recall of material, every students self esteem, integration of all students, and test scores all without taking time away from the teaching of material.
4. Achieve academic excellence.

2 – Poor to average elegance. The plan reflects some organization of ideas, but at times is difficult to follow due to lack of focus.

3 – Average elegance. The plan shows good organization of ideas and they mostly fit together and are orderly. There may be too many unnecessary details regarding some ideas while other critical things are neglected.

> The school's layout will be similar to OSSM. Except that the students are not required to live on campus. For each class a student takes e.g. Math, English, Science, History, Government, etc., there will be a mandatory meeting outside of the class, one day a week for study and discussion lasting an hour. There will not be study on Wednesday because of church. Having outside study everyday might seem like a big downer, so the teachers should make normal school hours more fun, and more interactive. This way students will look forward to fun ways of learning. Every game or activity should have a learning objective or strategy. Punishing bad behavior, and poor grades will be stricter in a sense, including stripping eligibility to participate in sports, organizations and other activities until grades are above D's not F's. Eligibility will be taken away not just at the end of periods such as, week, month or semester, but as soon as the grade is earned. School should also start an hour later. So at 9 instead of 8.

4 – Average to excellent elegance. The plan is easy to read and follow. The flow and focus of the plan make it easy to comprehend and it seems to fit well together. However it is not flawless, there are unnecessary ideas or missed points.

5 – Excellent elegance. The plan is easy to read and follow. The ideas flow together smoothly, are directly related to the problem and cover the critical elements of the plan. The adequate amount of detail is provided without being over the top. The plan is well thought out and organized.

> The goal of this new plan is to ensure that these educations programs within Oklahoma are increasing. I believe that this starts with the teachers. Each teacher will be carefully selected based on their education, and most importantly their motivation. These will be teachers who aren't as interested in a paycheck as they are in progression of education. They will be teachers who appear impressionable and who can impact the students.

Teachers will be required to spend one hour of personal assessment time with each student in his/her class once every quarter. Teachers will also be required to give an assessment tests over the particular curriculum weekly. The teaching style that will be applied in each classroom will involve teamwork, class competition, and lecture. At the beginning of a new chapter or section of curriculum the teacher will lecture over the topic. Students will be required to take notes and turn them in just to enforce the importance of studying and preparation of material for studying. Students will then be divided into 5 groups of 4 and prepare questions outlining the covered material. The students will be given 15 minutes. Next they will quiz each other (1 group to the other 4) to assess how much they learned of the unit. Tests will be given weekly covering the material. There will be a comprehensive test every quarter.