UNIVERSITY OF OKLAHOMA

GRADUATE COLLEGE

THINKING BEYOND YOUR OWN EXPERIENCE: HOW EXPERT CASES AND GUIDANCE ENHANCE CREATIVITY FOR NON-EXPERTS

A DISSERTATION

SUBMITTED TO THE GRADUATE FACULTY

in partial fulfillment of the requirements for the

Degree of

DOCTOR OF PHILOSOPHY

By

ARES BOIRA LOPEZ

Norman, Oklahoma

2025

Downloaded from SHAREOK. Persistent Handle URL: https://hdl.handle.net/11244/341390

THINKING BEYOND YOUR OWN EXPERIENCE: HOW EXPERT CASES AND GUIDANCE ENHANCE CREATIVITY FOR NON-EXPERTS

A DISSERTATION APPROVED FOR THE

DEPARTMENT OF PSYCHOLOGY

BY THE COMMITTEE CONSISTING OF

Dr. Shane Connelly, Chair

Dr. Constance Chapple

Dr. Hairong Song

Dr. Yaqing He

© Copyright by ARES BOIRA LOPEZ 2025

All Rights Reserved.

Acknowledgments

I am deeply grateful to those who have supported me throughout this journey. First and foremost, I thank my advisor, Dr. Shane Connelly, for your mentorship, patience, and encouragement, which have been instrumental in my growth as a researcher and professional. I truly appreciate the time, guidance, and opportunities you have provided. I also extend my sincere appreciation to my committee members, Dr. Constance Chapple, Dr. Hairong Song, Dr. Yaqing He, and former member Dr. Alex Harris-Watson, for their valuable feedback and revisions that strengthened this work. To Mark Fichtel, my colleague and friend, thank you for the many discussions and collaborative thinking that helped refine this dissertation. Your insight and support were invaluable. I am also grateful to the graduate and undergraduate students in the Shane Connelly Lab, especially Carson Freeman, Lilian Murdie, Emelie Schultz, and Amy Loya, for their dedication in assisting with data collection and coding. Finally, I thank my partner, Johannes Dierkes, whose unwavering support and encouragement provided the foundation I needed to complete this work, and my family, without whom I would not be here. To all of you, thank you.

Table of Contents

Abstract vi
Introduction 1
Creativity 2
Conceptual Combination 3
Case Source 5
Personal Case Selection 7
Case-Based Heuristics 11
Study 1 Method 14
Sample 14
General Procedures 14
Covariate Measures 15
Experimental Task 16
Predictors 17
Outcomes 18
Study 1 Results 18
Study 1 Discussion 19
Study 2 Method 21
Sample 21
Design and General Procedures 21
Experimental Task and Manipulations 22
Outcomes and Covariate Measures 23
Study 2 Results 23
Study 2 Discussion 26
Limitations 29
Theoretical and Practical Implications 30
Future Directions 32
Conclusions 33
References 34
Tables and Figures 46
Appendix A 56
Appendix B 59
Appendix C 60

Abstract

Research suggests that when individuals have limited prior knowledge, drawing from concrete past cases rather than abstract concepts enhances conceptual combination and creativity. However, it remains unclear whether these cases should stem from personal experiences or expert-provided sources. Additionally, there is little guidance on which aspects of personal experiences contribute to higher creative performance, warranting an initial investigation into their role in problem-solving. This two-study effort examined how 347 college students designed a high school curriculum using either personal experiences, expert-provided cases, or a combination of both, with some also receiving heuristic guidance to aid conceptual combination. Results showed that personal experiences associated with positive outcomes and emotions were linked to higher creative performance. However, Study 2 revealed that expert-provided cases combined with heuristic support led to greater conceptual combination effectiveness, improving solution quality and elegance, suggesting that external expert cases may be preferable for individuals with low-to-moderate expertise. Interestingly, more effective case combination was associated with reduced originality, underscoring a potential tradeoff between heavily relying on past cases and novelty. These findings highlight how case source and heuristic guidance shape creative problem-solving, offering insights into optimizing knowledge integration strategies for individuals with limited domain expertise.

Keywords: conceptual combination, case source, heuristics, creativity, quality, originality, elegance

Introduction

Creativity or the ability to generate novel and useful ideas (Kaufman & Sternberg, 2019) is essential for organizational growth and success in today's fast-changing world (Amabile & Conti, 1999; Brem et al., 2016; Klijn & Tomic, 2009). According to the creative process model, new ideas often emerge by combining elements from prior concepts or cases (Mumford et al., 1991). Historical examples, such as Benjamin Franklin, demonstrate how integrating past experiences – including goals, actions, and outcomes – can drive innovation (Mumford, 2002). Research suggests that this case-based approach can be as effective for creative performance as relying on textbook concepts and principles (Hunter et al., 2008).

Experts argue that when people have limited prior knowledge, making it difficult to extract relevant features and principles from abstract concepts, a case-based approach may be particularly beneficial for conceptual combination and idea generation (Reeves & Weisburg, 1994; Scott et al., 2005). However, non-experts may either lack domain-specific experiences to draw from or struggle to interpret expert cases they have not personally encountered. Despite these challenges, no empirical research has examined whether the *source* of prior cases, such as personal experience or external examples, affects creative performance for individuals with low to moderate expertise. In other words, does the origin of prior cases matter?

Thus, the focus of the present study is to compare the conceptual combination effectiveness and subsequent creative performance of non-expert individuals when working with personal experiences, external expert cases or a combination of the two. Literature provides no guidance for what types of personal experiences facilitate creative performance, suggesting the need for an initial study examining which aspects of personal cases are associated with higher creative performance. Study 1 and study 2 employed a methodology similar to prior work in this domain (Mumford & England, 2022) where individuals with a low-to-moderate level of expertise

combined insights from prior cases to solve a complex problem, and the final solution was rated for creative performance in terms of quality, originality, and elegance. This conceptual combination process involves a set of complex mental operations commonly referred to as heuristics. Scott and colleagues (2005) demonstrated that providing conceptual combination heuristic guidance tailored to prior cases facilitates the generation of new ideas and creative performance. However, the empirical findings from that study have not yet been replicated.

Accordingly, the aim of this study was to replicate and extend prior research by examining how the source of cases – specifically personal, external, or a combination – and the use of heuristic guidance influence both conceptual combination effectiveness and creative problem solving among non-experts. The findings are particularly useful for situations where non-expert individuals need to solve complex, ambiguous problems based on prior cases. Another objective was to determine which types of personal experiences lead to higher creative performance. These results are especially helpful when external cases are unavailable, and individuals must rely on insights from personal experiences.

Creativity

Creativity, commonly defined as the generation of high quality, original, and elegant ideas or solutions to ambiguous problems is a valuable resource for social and economic growth (Amabile et al., 1996; Besemer & O´Quin, 1999; Mumford & Gustafson, 2007; Sternberg & Lubart, 1995). Extensive research has explored how individuals and teams produce creative ideas and solutions (Hennessey & Amabile, 2010; Runco, 2004) assess creative thinking abilities (McCrae, 1987) and evaluate individual characteristics associated with superior creative performance (Weisberg, 2006). Mumford et al. (1991) developed a process analytic model of creative capacities highlighting specific discrete processes involved in creativity and creative performance. Figure 1 shows an updated version of this model (Vessey & Mumford, 2012).

INSERT FIGURE 1

According to this model, creative thinking begins with problem definition, followed by information acquisition and information selection (Baer, 2003; Finke et al., 1992; Rich & Weisberg, 2004). Selected pieces of information serve as a foundation for conceptual combination, the process of combining these pieces to facilitate idea generation and evaluation. Viable ideas are then selected, followed by implementation planning and active monitoring of outcomes. These processes operate dynamically, with any changes potentially prompting a revisit to earlier stages (Mumford et al., 2012). Scholars have amassed evidence supporting these processes (Baughman & Mumford, 1995; Lonergan et al., 2004; Mobley et al., 1992; Reiter-Palmon et al., 1998; Scott et al., 2005) with their effective execution correlating strongly with solution quality, originality, and elegance (Connelly et al., 2000; Mumford et al., 1996; Vincent et al., 2002). Although multiple distinct processing activities are involved in creative problem solving, conceptual combination is the basis for generating original, workable ideas (Mumford & McIntosh, 2017).

Conceptual Combination

Conceptual combination, commonly defined as the combination of elements from concepts or cases to generate new ideas, is one of the key processes in creative thought (Gill & Dube, 2007; Mumford et al., 1991; Scott et al., 2004). Historical accounts of notable innovators exemplify how groundbreaking ideas often arise from selecting and reconfiguring information from prior experiences (Haven, 2007; Philibin, 2005). An example of this phenomenon is public fire departments, an innovative solution that emerged from Benjamin Franklin's reflections on his experiences founding subscription libraries (Mumford, 2002).

Although early creativity scholars focused on the combination of concepts and principles (i.e., schematic knowledge) later work showed that it is possible for individuals to work with more complex knowledge structures, namely cases (Hunter et al., 2008). Cases contain information about past goals, courses of action, and the consequences of these actions (i.e., case-based knowledge). Research has found that insights from these cases can be used to generate solutions of comparable quality, originality, and elegance and are in fact, preferred under certain conditions (Mumford et al., 2006; Scott et al., 2005). Because case-based knowledge can include information about concepts and principles (i.e., schematic knowledge) the associations between concepts (i.e., associational knowledge) and the applications of principles in context, it is a more comprehensive and richer knowledge structure.

With respect to creative thinking, literature suggests that drawing insights from prior cases (i.e., case-based conceptual combination) rather than solely using concepts and principles is preferable under the following conditions. First, problem domains emphasizing practical real-world problems versus theoretical problems benefit from case-based conceptual combination (Kolodner, 1993; Koplinka et al., 1988). Second, combining information from prior cases provides value when a set of well-organized concepts and principles is not available (Mumford, 2000). Third, when problems are so ambiguous and complex that applicable principles are unclear, case-based conceptual combination is helpful (Reeves & Weisburg, 1994). Fourth, when the individuals generating the solutions lack expert knowledge about concepts and principles, case-based conceptual combination facilitates creative performance (Scott et al., 2005).

To date, there are two key empirical studies on case-based conceptual combination, one by Scott and colleagues (2005) and the other by Hunter and colleagues (2008). Both studies asked participants with low-to-moderate expertise to employ case-based conceptual combination to

generate a creative solution to a complex problem, such as developing a new educational curriculum for an experimental school. The former provided external expert cases to participants, while the latter asked participants to use their own past experiences. The findings played a pivotal role in advancing the literature on case-based conceptual combination, yet they prompted a research question regarding the most optimal source of cases used in conceptual combination. A case-based approach has been recommended for individuals who have less prior knowledge available (Reeves & Weisburg, 1994), however, these individuals may either lack domain-specific experiences to draw from or struggle to interpret expert cases they have not personally encountered. It is unclear whether they should rely on personal experience (see figure 2), explore and learn from expert past cases (see figure 3), or use a combination of both. The following section discusses the potential advantages and disadvantages of each approach and their impact on conceptual combination effectiveness and subsequent creativity.

INSERT FIGURE 2

INSERT FIGURE 3

Case Source

Direct experiences can help individuals understand task requirements, learn from errors, and improve strategies (Argote & Todorova, 2007). Firsthand exposure to situations not only imparts explicit knowledge but also tacit knowledge and competencies or knowledge and skills learned during action that are challenging to verbalize (Gino et al., 2010; Mitchell et al., 2021; Nonaka et al., 1996). This tacit knowledge can greatly contribute to innovation, as it provides

perceptual, motor, affective, introspective, and social information that is hard to obtain otherwise (Kucharska & Erickson, 2023). Recent cognitive theorists have recognized the importance of this situated knowledge for case-based conceptual combination (Wu & Barsalou, 2009; Yeh & Barsalou, 2006). Lynott and Connell (2010) presented a new term called embodied conceptual combination to describe the process in which individuals combine characteristics of mentally simulated situations that contain actions, emotions, and beliefs, as they think this is a superior process than using non-simulated information.

On the other hand, scholars have found that individuals tend to over-rely on personal experiences, and that this can foster inflexible thinking, leading to hasty, superficial judgments prone to errors (Tien et al., 2019). When confronted with seemingly similar yet structurally different problems, individuals tend to apply prior solutions without tailoring them to the new situation, resulting in worse outcomes than those approaching the new problem with a fresh perspective (Frensch & Sternberg, 1989). Thus, while the use of personal experiences can bolster judgment and creative potential, it can also dampen divergent thinking and creative performance (Tien et al., 2019). Additionally, non-expert individuals frequently lack domain-related experiences, particularly high-quality ones, making it challenging to rely on personal cases to generate high-quality solutions. Working with external expert cases grants them access to otherwise inaccessible knowledge that contributes to creative performance (Argote & Ingram, 2000; Bandura, 1977; Gino et al., 2010: Reilly, 2008).

Therefore, we propose that individuals with low-to-moderate expertise will execute conceptual combination more effectively and generate better solutions when working with external cases than when working with personal cases. Moreover, given that conceptual combination occurs

before generating the final solution, we propose that conceptual combination effectiveness mediates the relationship between case source and creative performance (see Figure 4).

Hypothesis 1: Working with external expert cases leads to higher conceptual combination effectiveness than working with personal cases or a mix of both.

Hypothesis 2: Working with external expert cases leads to higher levels of creative performance (i.e., quality, originality, and elegance) than working with personal cases or a mix of both

Hypothesis 3: Conceptual combination effectiveness mediates the effects of case source on creative performance (i.e., quality, originality, and elegance).

Personal Case Selection

In this research, we assume that when individuals seek external cases, they typically focus on examples from experts addressing similar situations. These cases, often accessed through news outlets, reports, books or articles, tend to be well articulated and accurate, highlighting effective solutions and/or major failures that serve as cautionary examples. In contrast, there are no specific constraints or guidance for selecting personal cases, other than their relevance to the problem at hand. Understanding what makes certain personal cases more useful for creative problem solving is important for two reasons. First, there are situations where external sources are unavailable, leaving individuals to rely solely on their existing knowledge and past experiences. Second, it is unclear what characteristics make a personal experience better than others for conceptual combination. Additionally, guidance is critical because individuals often possess a vast number of experiences related to a given problem domain. Prior research on case-based conceptual combination suggests that working with more than two or three personal cases can lead to cognitive overload, making it harder to effectively combine elements across cases and ultimately reducing

the likelihood of generating innovative solutions (Scott et al., 2005). In this section, we explore various factors that may influence the usefulness of personal cases.

Research has shown that case characteristics matter when extracting information to generate viable solutions to solve complex problems, and that poorly constructed cases can impede case-based learning and sensemaking mechanisms (Bagdasarov et al., 2012; Harkrider et al., 2012; Johnson et al., 2012; Thiel et al., 2011). Experts have recommended reflecting on the characteristics of strong and weak cases because it prompts the consideration of effective strategies and areas for improvement (Mulhearn et al., 2020). Supporting this notion, Antes and Mumford (2012) and Vessey and colleagues (2011) found that a balanced approach, considering both positive and negative elements, led to the most robust problem solutions. However, a later study found that participants generated stronger problem solutions when reflecting on positive personal experiences, rather than on negative ones (Antes et al., 2012). This aligns with the proposition that reflecting on negative experiences may pose a psychological threat and reduce cognitive performance (Sedikides & Green, 2004). Given the mixed findings, we present the following research questions:

Research Question 1: How might the inclusion of (a) positive outcomes and (b) negative outcomes in personal cases relate to conceptual combination effectiveness?

Research Question 2: How might the inclusion of (a) positive outcomes and (b) negative outcomes in personal cases relate to creative performance (i.e., quality, originality, and elegance)?

In addition, experts have argued that it is easier to remember details of and draw insights from emotionally laden cases (Atkinson, 2008; Bagdasarov et al., 2013; Herreid, 1998; Kim et al., 2006). Emotions are always somewhat present in personal experiences and those more heavily

charged with emotions are typically more memorable and readily activated when addressing problems compared to neutral events (D'Argembeau & Van der Linden, 2007). For instance, including descriptions of characters' emotional experiences when describing past cases resulted in better acquisition of case-based knowledge and production of better solutions to ethical problems (Thiel et al., 2011).

There are mixed findings as to whether that is the case for both positive and negative emotions. A set of studies have shown that both types of emotions can have beneficial effects, with positive emotions facilitating rapid idea generation, and negative emotions motivating individuals to seek improvements (Baas et al., 2008; George & Zhou, 2002; To et al., 2012). Others have found that mild positive emotions can enhance basic cognitive processes associated with creativity, while negative feelings are generally associated with decreased creativity (e.g., Bruner et al., 1955; Greene et al., 1988; Isen et al., 1987; Isen et al., 1985; Sullivan & Conway, 1989). It has been argued that past experiences that induce strong negative emotions may divert resources from cognitive processing, leading to suboptimal performance in creative problem solving (Fiedler & Garcia, 1987).

Individuals investigating the relationship between emotions and creativity have also looked at the level of arousal of emotions and how that might affect creative performance (Baas et al., 2008). For instance, some positive and negative emotions are considered activating (e.g., excited, angry) while others are considered deactivating (e.g., calm, sad). Activating emotions facilitate cognitive flexibility, abstract thinking, processing speed, and access to long-term memory, all of which is conducive to conceptual combination effectiveness and creativity (Baddeley, 2000; Conner & Silvia, 2015; Damasio, 2001; Dietrich, 2004; Strasbaugh & Connelly, 2022). This is attributed to the release of dopamine and noradrenaline associated with activation and arousal,

which enhances working memory capacity and cognitive abilities (Baddeley, 2000; Flaherty, 2005; Usher et al., 1999). The studies to date have examined state and trait emotions in relation to creative performance, yet none have explored working with emotion infused cases and the impact of these cases on creative problem solving. Therefore, we propose the following research questions:

> *Research Question 3:* How might the inclusion of (a) positive activating emotions, (b) positive deactivating emotions, (c) negative activating emotions, and (d) negative deactivating emotions in personal cases relate to conceptual combination effectiveness?
>
> *Research Question 4:* How might the inclusion of (a) positive activating emotions, (b) positive deactivating emotions, (c) negative activating emotions, and (d) negative deactivating emotions in personal cases relate to creative performance (i.e., quality, originality, and elegance)?

The last case characteristic we examine in the current study is the degree of similarity between personal cases. Although no empirical studies have examined the effects of case similarity on creativity, we can draw from the extensive literature on concept similarity or diversity, and how that impacts conceptual combination effectiveness and creative performance. The findings from this body of literature are mixed (see Finke et al., 1992; Mobley et al., 1992; Mumford et al., 1997; Scott et al., 2005). On one hand, working with discrepant concepts forces individuals to resolve contradictions that can lead to more original thinking (Baughman & Mumford, 1995; Estes & Ward, 2002; Wilkenfeld & Ward, 2001). Thus, employing diverse concepts not commonly associated with each other can lead to the generation of novel problem solutions (MacKinon, 1962; Mednick et al., 1964; Mumford & Gustafson, 1988; Mumford et al., 1991). Mobley and colleagues (1992) tested this hypothesis employing a conceptual combination task and found that presenting unrelated rather than related concepts resulted in more original combinations. Similarly, Kohn and

team (2011) found that unrelated concepts led to more original combinations, although this effect did not extend to the final problem solution's originality.

On the other hand, combining similar concepts should be easier because their commonalities and differences are much more apparent, thereby facilitating the identification of potential integrations and modifications to generate new solutions (Wilkenfeld & Ward, 2001). In addition, the compatibility between related concepts should reduce the need to extensively modify existing knowledge to incorporate them sensibly, thus reducing cognitive load. In alignment with these arguments, Mobley and colleagues (1992) found that working with related concepts produced higher-quality combinations. Kohn and team (2011) further supported this notion with their findings that individuals working with related concepts generate more combinations than those working with unrelated concepts. Given the mixed findings and the lack of research examining whether the results stated above generalize to cases, we propose the following research questions:

Research Question 5: How might the degree of personal case similarity relate to conceptual combination effectiveness?

Research Question 6: How might the degree of personal case similarity relate to creative performance (i.e., quality, originality, and elegance)?

Regardless of the characteristics and the source of the cases used in case-based conceptual combination, creativity experts recommend using a set of heuristics as discussed in the following section (Mumford & England, 2022; Mumford et al., 2013; Scott et al., 2005).

Case-Based Heuristics

Cases are complex knowledge structures that require careful evaluation and restructuring to develop effective solutions. Integrating elements from multiple cases – assessing their relevance,

rearranging components, and tailoring them to a specific situation – demands both intelligence and cognitive effort (Thomas & McDaniel, 1990). For individuals with low to moderate expertise, step-by-step guidance may be particularly beneficial in navigating this process.

Scott et al. (2005) proposed a set of mental operations (i.e., case-based heuristics) to facilitate case-based conceptual combination: (1) identifying key characteristics of each case, (2) analyzing their strengths and weaknesses, (3) combining strengths to develop an initial solution, and (4) forecasting the potential positive and negative outcomes. However, empirical support for these heuristics remains limited and somewhat mixed, highlighting the need for additional studies. While Scott et al. (2005) found a positive relationship between effective heuristic application and solution quality, originality, and elegance, training programs designed to improve these skills have shown no measurable post-intervention impact on creative performance (Mulhearn et al., 2020). Given this uncertainty, further research is needed to confirm whether following these heuristics leads to improved conceptual combination effectiveness and creative performance. This study was designed to test the following hypotheses:

> *Hypothesis 4*: Providing case-based heuristics to follow leads to higher conceptual combination effectiveness than not providing these heuristics.
>
> *Hypothesis 5*: Providing case-based heuristics to follow leads to higher levels of creative performance (i.e., quality, originality, and elegance) than not providing these heuristics.
>
> *Hypothesis 6*: Providing case-based heuristics to follow influences creative performance (i.e., quality, originality, and elegance) mediated by conceptual combination effectiveness.

Although both case source and the presence of heuristics have been proposed to independently influence conceptual combination and creative performance, it is also important to consider how these factors may interact. Prior literature suggests that case-based heuristics are

particularly helpful when individuals face high task complexity or lack sufficient expertise to navigate ambiguous information structures (Mumford et al., 2013; Scott et al., 2005). Personal cases, by nature, may be more difficult to work with given their potential emotional complexity, lack of structure, and variability in relevance. As such, heuristics may be especially beneficial when individuals are drawing from their own experience, helping them extract and recombine relevant elements more effectively. In contrast, external cases – typically curated, structured, and expert-informed – may already provide a degree of scaffolding, potentially reducing the incremental value of heuristics. Thus, we expect that the benefits of providing heuristics will be more pronounced for individuals working with personal or mixed-source cases than for those working with expert external cases. This suggests a moderation effect, whereby the impact of heuristics depends on the nature of the case source. To test this interaction, we propose the following hypothesis:

> *Hypothesis 7*: The effect of case-based heuristics on (a) conceptual combination effectiveness and (b) creative performance (i.e., quality, originality, and elegance) will be moderated by case source, such that the benefits of heuristics will be greater when working with personal or mixed cases than with external expert cases.

Before testing these hypotheses, study 1 empirically tests the research questions regarding the relationships between personal case characteristics, conceptual combination effectiveness and creative performance (i.e., solution quality, originality, and elegance). Findings from study 1 will guide prompting in study 2 when asking participants to think of past experiences.

Study 1 Method

Sample

The sample for this study comprised 84 undergraduate students, 15 male and 69 female between the ages of 18 and 25. Most of the sample identified as European/Caucasian (54.8%). The remaining participants identified as Asian (9.5%), Hispanic/Latino (13.1%), African American/Black (4.8%), American Indian/Native American or Alaska Native (4.8%), Hawaiian Native or Other Pacific Islander (3.6%), Middle Eastern (n = 6, 7.1%), or Asian American (2.4%). They were recruited via SONA, the university's online participant recruitment system, and were given course credit to fulfill an educational requirement. Participants completed the study in person, using printed materials and an online Qualtrics survey.

General Procedures

Each session began with participants reading and signing the informed consent form and completing two timed covariate measures assessing intelligence and divergent thinking. This was followed by presenting participants with general task materials adapted from prior problem solving studies, in which they assumed the role of a principal of a new experimental high school (Hunter et al., 2008). The materials included goals for the task and things to consider while working through the task. Participants were asked to retrieve and write about two prior personal high school cases related to the task at hand. We asked for two cases and not more because it is the minimum amount one needs to generate a combination, yet the task does not become too difficult given the complexity of working with cases (Scott et al., 2005). After writing down their cases, they followed the case-based heuristics to guide conceptual combination, writing 4-8 sentences for each step in the heuristics guidance. The final step was to formulate a plan for how they would structure the functioning of their school. After completing this task, participants filled out several individual difference covariate measures and were debriefed.

Covariate Measures

Divergent thinking or generating novel ideas by exploring multiple possibilities, was assessed using Merrifield et al.'s (1962) Consequences measure. This measure prompted participants to generate novel ideas that might be potential results of unlikely events. For example, one prompt asks participants to consider "What would be the results if people no longer needed or wanted sleep?" Participants were instructed to generate as many consequences as possible for each prompt, with a time limit of two minutes per prompt. This measure typically yields internal consistency coefficients above .70 (Vincent et al., 2002). Intelligence was measured using the Employee Aptitude Survey, a verbal reasoning measure that presents six problem scenarios, with each scenario presenting four or five known facts about the problem, and five conclusions for each problem (Ruch & Ruch, 1963). Participants must indicate whether each conclusion is false, true, or unknown given only the facts of the problem. This measure tends to yield internal consistency coefficients over .80 (Grimsley et al., 1985).

The first untimed covariate measure that was presented to participants after a demographic information form was the with the Five-Factor Model Questionnaire, assessing the Big Five personality characteristics of extraversion, agreeableness, neuroticism, openness, and conscientiousness (Gill & Hodgkison, 2007). Participants indicated, on five-point Likert scales, the extent to which each of the 80 items reflects their own personality. The resulting 16-item scales yielded internal consistency reliability above .70. Domain expertise was assessed with Scott et al.'s (2005) background data measure, asking participants about their exposure to and interest in issues surrounding education. This measure yielded an internal consistency coefficient of .70. Because all participants were expected to have low to moderate expertise in the education domain, it was important to measure domain-specific knowledge to accurately characterize the sample. Capturing this information allowed us to identify any participants with unusually high expertise and

statistically control for potential expertise-related effects on the outcomes of interest. Because creative problem solving requires participants to think deeply, participants were asked to complete Cacioppo et al.'s (1984) measure of need for cognition. This 18-item measure asked participants to rate on a five-point Likert scale their preference for engaging in intellectually stimulating tasks (Watts et al., 2017). This scale yielded an internal consistency coefficient of .81.

Experimental Task

Participants were asked to participate in a low-fidelity simulation task adapted from Strange and Mumford (2005) in which they take on the role of a principal at a new experimental high school (see Appendix A). Prior studies that have used this task have indicated undergraduate students generally find the task to be both engaging and realistic, which suggests they are motivated when working on the task.

As the principal of the new experimental high school, participants were asked to improve the academic success of the school's student body by creating a new curriculum for the school. In this task, participants were presented with a description of the high school, which notes that the school was established by the State Department of Education based on funds allocated as part of a national effort to institute experimental secondary schools in each state. The purpose of this national effort was to establish new academic programs that would contribute to the improvement of the student body. At the end of each academic year, school performance was to be assessed and compared to other high schools in the state as well as other newly established experimental schools in different states on standard educational outcomes.

Participants in this study were informed that the experimental schools with the greatest performance gains would be allotted additional funding in the following academic year and that they would be asked to circulate their curriculum to the other secondary schools in their state. After reading through this introductory material, participants were provided with a more in-depth,

detailed description of the experimental school as well as the state educational system more generally. Participants were informed about the current problem that led to the state's schools being ranked 49th in the nation in terms of school funding and 47th nationally in terms of academic performance. Participants were further informed that their teaching method should help student members of special populations, such as academically disabled and gifted students. Moreover, participants were told that funding for the school would provide enough teachers to have a ratio of one instructor for every 20 students. These teachers would be paid above-average salaries for their involvement in the experimental school program.

After reading this information, participants wrote about two prior experiences related to the problem at hand and used them to think of a solution. After writing these cases, participants followed a set of case-based heuristics and wrote four to six sentences for each step. After completing the heuristics, they were asked to formulate a two-to-three-page plan "to achieve academic excellence" in the new school. They were asked to include any elements such as process improvement ideas, teaching strategies, and special activities or programs that they felt would help the school succeed. This plan, coupled with the answers provided in each of the case-based heuristics served as the basis for the dependent variable ratings.

Predictors

The extent to which cases included positive and negative outcomes, positive and negative activating and deactivating emotions, and the degree of similarity across cases were assessed by trained raters using 5-point benchmark rating scales with examples for high, medium, and low levels of each construct. Prior to making any ratings, judges were provided with frame-of-reference training to familiarize them with the context, the variables, the examples, and rating errors/biases to avoid. The interrater reliability ($r*wg$) ranged from .71 to .78 across these rated variables.

Outcomes

Conceptual Combination Effectiveness. To assess conceptual combination effectiveness, each step of the case-based heuristics – (1) identifying case characteristics, (2) listing strengths and weaknesses, (3) combining strengths into an initial plan, and (4) forecasting outcomes – was rated by three trained raters, on a 5-point benchmark rating scale with examples for high, medium, and low levels of effectiveness. See sample benchmark rating scale for identifying key characteristics in Appendix B. The interrater reliability (*r*wg*) ranged from .73 to .82 across these rated steps.

Solution Quality, Originality and Elegance. The creative problem-solving task required participants to prepare a final proposal for a new curriculum for the school. The final proposal was coded for quality, originality, and elegance by three trained raters using a 5-point benchmark rating scale used in previous studies (Osburn & Mumford, 2006; Friedrich & Mumford, 2009; Connelly & Ruark, 2010). Quality was defined as the degree to which the proposed solution is realistic, practical, and appropriate for the situation. Originality referred to the extent to which the participant drafts a novel solution, and elegance was the extent to which the solution is articulated in a concise manner. Low-and high-quality responses were selected from participant data for each scale to create final benchmarks. See a sample benchmark rating scale for solution quality in Appendix C. Interrater reliability (*r*wg*) was .77 for quality, .63 for originality, and .73 for elegance.

Study 1 Results

Table 1 presents correlations and descriptive results for predictors and outcome variables and Table 2 presents multiple regression analysis results. To address the research questions pertaining to the relationship between each case characteristic with conceptual combination effectiveness, solution quality, originality and elegance, we discuss the observed correlations and

present the results of multiple regression analysis examining these relationships when controlling for other case features and control variables.

The presence of positive outcomes had a positive and moderate relationship with conceptual combination effectiveness (r = .31, p < .01) whereas activating and deactivating positive emotions had slightly smaller positive correlations with this outcome (r = .27, p < .05; r = .24, p < .05). However, multiple regression analysis showed that no characteristic was predictive of conceptual combination effectiveness beyond GPA, F change (7, 73) = 1.32, p > .05, R^2 change = .10.

Although case characteristics did not have significant zero order correlations with solution quality, multiple regression analysis showed that they predicted solution quality above and beyond intelligence (b = .05, t = 3.30, p < .01) F change (7, 75) = 3.02, p < .01, R^2 change = .19, R^2 = .32, with positive outcomes being the only significant predictor (b = .65, t = 3.40, p < .01). Positive outcomes also had a positive and moderate relationship with solution elegance (r = .31, p < .01) and activating and deactivating positive emotions had a positive and weak relationship with this outcome (r = .26, p < .05; r = .22, p < .05). Multiple regression revealed that case characteristics predict solution elegance above and beyond intelligence, neuroticism, and English proficiency, F change (7, 73) = 3.93, p < .01, R^2 change = .20, R^2 = .46, with positive outcomes as the only significant predictor (b = .55, t = 3.01, p < .01).

Study 1 Discussion

Positive outcomes and emotions in past experiences enhanced both the quality and elegance of problem solutions, independent of individual intelligence differences. Although these characteristics were not predictive of conceptual combination effectiveness beyond GPA, they correlated significantly with this outcome, too. Prior research presented conflicting views on the relationship between outcome valence in cases and creative performance (e.g., Mulhearn et al.,

2020; Sedikides & Green, 2004). Our findings are consistent with work suggesting that reflecting on positive personal experiences leads to stronger problem solutions (e.g., Antes et al., 2012). However, our results did not support prior findings suggesting that negative experiences hinder creativity due to psychological threat or narrow thinking as argued by some, our results showed that it did not make a difference. Perhaps negative experiences are unhelpful simply because they provide information about what *not to do* rather than what *to do*.

Similarly, the literature also presents mixed arguments on the relationship between case emotions and creative performance, with some advocating for the positive influence of all emotions (e.g., To et al., 2012) and others arguing that only positive emotions are beneficial (e.g., Fiedler & Garcia, 1987). Our findings align with the latter, as negative emotions had little to no impact on conceptual combination effectiveness and creative performance. Additionally, the level of emotional arousal—whether emotions were activating or deactivating—did not significantly affect these outcomes either. This supports previous findings that both highly and mildly activating positive emotions are conducive to creativity, while negative emotions are unrelated (Conner & Silvia, 2015). This is also consistent with Fredrickson's (2004) broaden-and-build theory regarding the influence of positive emotions on broadening mindset and thought-action repertoires thereby facilitating creative thinking.

Taken altogether, the empirical evidence of the current effort points at the creative benefits of drawing insights from past experiences that have positive outcomes and positive emotions. This evidence contributes to theory on creative thought, particularly the stage of case selection, where little information has been available regarding which personal experiences are most useful to combine and generate novel problem solutions. The findings also offer practical applications, such

as the recommendation to defer to successful past experiences when external sources are unavailable, and one must solve a problem creatively.

These findings informed the development of materials for study 2, which examines the effects of case source and case-based heuristics on conceptual combination effectiveness and creative performance. Participants in study 2 who were asked to work with their own personal experiences, were instructed to think about experiences that contained positive outcomes and positive emotions. The goal of this strategy was to compare the influence of using optimal personal cases versus external expert cases.

Study 2 Method

Sample

This study comprised a sample of 263 undergraduate students, 82 male, 178 female and 3 non-binary between the ages of 18 and 41 (M = 19). Most of the sample identified as European/Caucasian (58.2%). Other reported ethnicities that included Hispanic/Latino (12.5%), African American/Black (9.9%), Asian (7.2%), Middle Eastern (4.9%), American Indian/Native American or Alaska Native (3.4%), Asian American (1.9%), and Hawaiian Native or Other Pacific Islander (1.9%). Similarly to study 1, they were recruited via SONA and given course credit to fulfill an educational requirement. Participants completed the study in person, using printed materials and an online Qualtrics survey.

Design and General Procedures

A 3 x 2 between-subjects design was used, manipulating case source (personal, external expert, mixed) and heuristics (no guidance vs. guidance). Participants were randomly assigned to one of the six experimental conditions. Each session began with participants reading and signing the informed consent form and completing two timed covariate measures assessing intelligence and divergent thinking. This was followed by presenting participants with general task materials

adapted from prior problem-solving studies, in which they assumed the role of a principal of a new experimental high school (Hunter et al., 2008; Scott et al., 2005). The materials included goals for the task, as well as things to consider while working through the task. Participants were either asked to write about two personal cases, read two expert external cases, or do one of each. After writing or reading the information, they were asked to engage in conceptual combination, and either received heuristic guidance or not. The final step was to formulate a plan for how they would structure the functioning of their school. After completing this task, participants filled out several individual difference covariate measures and received the debriefing.

Experimental Task and Manipulations

The experimental task in this study was the same one that was used in study and thus has been extensively described. The main differences reside in the manipulations incorporated in this study, such that participants were assigned to one of six conditions: (1) personal cases with no heuristic guidance, (2) personal cases with guidance, (3) external expert cases with no guidance, (4) external expert cases with guidance, (5) one personal and one external expert case without guidance, and (6) one personal and one external expert case with guidance.

Case Source. The case source manipulation involved assigning participants to work with either two personal cases, two external expert cases, or a combination of one personal and one expert case. The external cases were derived from a review of best practices in high school curricula, drawing from sources such as Mitchell & Sutherland (2020), Mitchell (2008), Berger et al. (2022), Mahoney et al. (2020), and CASEL's Social and Emotional Learning Practice Playbook. These sources provided evidence-based strategies for inclusive education, teacher well-being, and social-emotional learning.

Heuristics Guidance. The heuristics manipulation provided participants with guidance on a set of case-based heuristics in the conceptual combination process, writing 4-6 sentences for

each, or simply asking participants to combine the cases and document the process (Scott et al., 2005). Case-based heuristics provided in the guidance conditions included (1) identifying critical case characteristics, (2) listing strengths and weaknesses of each case, (3) combining strengths listed in step 2 and creating an initial model, and (4) predicting positive and negative outcomes of the model if it were implemented.

Outcomes and Covariate Measures

The dependent variables and covariates in this study were identical to the ones employed in study 1. For the rated steps involved in conceptual combination effectiveness, interrater reliability (*r*wg*) ranged from .68 to .80. The internal consistency of the measure was α = 84. For solution quality, originality and elegance, interrater reliability (*r*wg*) was .80, .74, .77, respectively. Internal consistency for all covariate measures was above .70.

Study 2 Results

Table 3 presents correlations and descriptive results for predictors, outcome variables and control variables. Table 4 presents descriptive results for outcomes for each condition separately. Tables 5 and 6 presents path coefficients and indirect effects for the mediation models. ANCOVAs (Analysis of Covariance) with post-hoc pairwise comparison with Bonferroni correction to assess direct and interactive effects of case source and heuristics on conceptual combination effectiveness and creative performance. To examine the effects of case source and heuristics guidance on creative performance as mediated by conceptual combination effectiveness, Hayes Macro Model 4 was used (Hayes & Preacher, 2010). Significant mediational effects resulted if the 95 percent confidence interval ($CI_{.95}$) of the indirect effect does not contain zero. Control variables that showed a significant zero-order correlation with the outcome of interest were included in the analysis.

Addressing hypothesis 1 and 2, case source did not have a direct effect on conceptual combination effectiveness nor creative performance. However, our mediation analysis provided support for hypothesis 3.. The relationship between case source and solution quality was mediated by conceptual combination effectiveness ($CI_{.95}$ = .006, .182). The regression coefficient between case source (personal vs. external) and conceptual combination effectiveness was statistically significant (b = .30, p < .05) as was the regression coefficient between conceptual combination effectiveness and solution quality (b = .42, p < .001). The relationship between case source and solution originality was also mediated by conceptual combination effectiveness ($CI_{.95}$ = -.063, -.002). The regression coefficient between case source (personal vs. external) and conceptual combination effectiveness was statistically significant (b = .31, p < .05) and the regression coefficient between conceptual combination effectiveness and solution originality was significant but negative (b = -.14, p < .05). Lastly, the relationship between case source and solution elegance was mediated by conceptual combination effectiveness ($CI_{.95}$ = .006, .151) too. The regression coefficient between case source (personal vs. external) and conceptual combination effectiveness was statistically significant (b = .31, p < .05) as was the regression coefficient between conceptual combination effectiveness and solution elegance (b = .39, p < .001). In these mediation models, differences in conceptual combination effectiveness were observed between individuals working with personal cases and those working with external cases, while no significant differences emerged between those using both a personal and an external case and other source types.

Addressing hypothesis 4, providing case-based heuristics had a positive main effect on conceptual combination effectiveness, F (1,257) = 8.39, p < .01, η_p^2 = .03, such that those who received guidance got a higher score (M = 10.58, SE = .31) than those who did not (M = 9.29, SE = .32). Addressing hypothesis 5, providing case-based heuristics did not predict creative

performance. However, in response to hypothesis 6, several mediation analyses were significant. The relationship between heuristics and solution quality was mediated by conceptual combination effectiveness ($CI._{95}$ = .039, .196). The regression coefficient between heuristics (no guidance vs. guidance) and conceptual combination effectiveness was statistically significant (b = .37, p < .01) as was the regression coefficient between conceptual combination effectiveness and solution quality (b = .44, p < .001). The relationship between heuristics and solution originality was also mediated by conceptual combination effectiveness ($CI._{95}$ = -.062, -.004). The regression coefficient between heuristics (no guidance vs. guidance) and conceptual combination effectiveness was statistically significant (b = .36, p < .01) and the regression coefficient between conceptual combination effectiveness and solution originality was also significant but negative (b = -.13, p < .001). The relationship between heuristics and solution elegance was mediated by conceptual combination effectiveness ($CI._{95}$ = .025, .154) too. The regression coefficient between heuristics (no guidance vs. guidance) and conceptual combination effectiveness was statistically significant (b = .35, p < .01) as was the regression coefficient between conceptual combination effectiveness and solution elegance (b = .40, p < .001).

Finally, regarding Hypothesis 7, the interaction between case source and heuristics guidance on conceptual combination effectiveness and creative performance was non-significant, offering no support for the idea that heuristics are particularly beneficial for the quality originality or elegance of a plan when working with personal cases. However, an ANCOVA for conceptual combination followed by post hoc comparisons examining differences across experimental conditions revealed a significant overall effect on conceptual combination effectiveness, $F(5, 257) = 2.80$, $p < .05$, $\eta_p^2 = .05$. Specifically, participants who worked with external expert cases and received heuristic guidance (M = 10.85, SE = 0.52) outperformed those who worked with personal

cases and received no guidance (M = 8.59, SE = 0.53), suggesting that the combination of expert case material and heuristic structure may support more effective conceptual integration.

Study 2 Discussion

This study aimed to examine the impact of case source – whether personal, external or a mix – and to replicate the effects of case-based heuristics, as identified by Scott and colleagues (2005) on conceptual combination effectiveness and creative performance. As expected, participants who received case-based heuristic guidance were better at integrating elements from past cases than those who did not receive guidance. However, contrary to our predictions, this guidance did not directly enhance creative performance, which was measured in terms of solution quality, originality, and elegance. Our mediation analyses suggest that the positive impact of case-based heuristics on solution quality and elegance was driven by improvements in conceptual combination effectiveness. A similar pattern emerged for case source: working with external cases led to higher-quality, more elegant solutions than working with personal cases by improving conceptual combination effectiveness. Interestingly, we found the opposite effect for originality – while both case source and heuristics enhanced conceptual combination effectiveness, this, in turn, had a negative effect on originality. In the following sections, we explore these findings further, discuss potential limitations, and suggest directions for future research.

A key question in this study was whether the source of prior cases matters for conceptual combination and creative problem solving. One possibility, as previously suggested, is that working with personal experiences is easier because they contain a wealth of nuanced knowledge and skills that are difficult to capture in external cases. Additionally, individuals may find it harder to fully grasp external cases compared to their own experiences, with which they are naturally more familiar. However, another possibility is that people tend to over-rely on personal experiences simply because they are readily available, even when these experiences may not be the best fit for

the problem at hand. For our sample, which consisted of individuals with low to moderate expertise in the task domain, the lack of high-quality domain experience may have played a crucial role. In this case, external cases provided them with access to knowledge they might not have otherwise had, ultimately contributing to better creative performance. Based on this reasoning, we hypothesized that working with external cases would enhance both conceptual combination effectiveness and creative performance, a prediction that our findings largely supported.

Our findings indicate that individuals with low to moderate expertise find it easier to combine elements from external cases than from their own experiences. This approach leads to solutions that are both higher in quality and more elegant. It appears that personal experiences, even in combination with external cases may not be as beneficial as strictly working with external examples in creative problem solving for non-experts. This observation aligns with existing research on expertise and creativity (e.g., Weisberg, 2015). Cases provide information about goals, actions, procedures, outcomes, and constraints, encompassing both technical and social aspects, making them complex knowledge structures. The more personal experience we have in a particular field, the better organized and structured our knowledge becomes. Experts, having a vast library of cases, develop well-articulated and accurate prototypes, representative cases that incorporate patterns from all their experiences, which they can use to generate higher-quality solutions (Baer, 2015). Non-experts, however, may lack the experiences needed to create these prototypes, leaving them with access to only a few cases that might be exceptions or of lower quality. In such situations, providing non-experts with well-articulated and accurate external cases enhances their ability to combine concepts effectively, leading to higher-quality and more elegant ideas.

Another key question in this study was whether providing guidance during conceptual combination would enhance effectiveness and in turn creativity for individuals with low to

moderate expertise. Consistent with prior research, our findings confirm that individuals integrate elements from prior cases more effectively when they follow the heuristics developed by Scott et al. (2005) rather than working without guidance. This improved effectiveness led to the generation of higher-quality and more elegant ideas. A key strength of this study is its ability to reveal how case source and heuristic guidance interact to influence conceptual combination. Our results show that non-experts perform significantly better when working with expert-provided cases and receiving guidance on how to integrate them. Notably, these factors do not directly impact creative performance but do so indirectly through their effect on conceptual combination effectiveness. This finding highlights the role of both source (where the knowledge comes from) and guidance (how it is applied) in shaping the creative thinking process (how well ideas are combined) which ultimately affects the final creative outcome (what is produced).

Interestingly, our findings indicate that the effectiveness of combining prior cases negatively impacted solution originality. This result contrasts with prior work supporting the creative process model, although empirical research specifically examining the role of cases remains limited, most notably addressed by Scott et al. (2005) and Hunter et al. (2008). One possible explanation for this unexpected result is that solutions based on structured combinations of prior cases may appear more familiar and thus less novel. In contrast, participants who struggled to integrate prior cases may have generated more unstructured, original ideas, resulting in proposals that appeared more creative in the context of redesigning a high school curriculum.

However, this finding should be interpreted cautiously. To draw strong conclusions about whether this is a true effect rather than an artifact, replication is necessary. In fact, our first study found a significant positive correlation between conceptual combination effectiveness and plan originality, directly opposing the results of Study 2. Yet the inter-rater reliability (IRR) for plan

originality in Study 1 was below the acceptable threshold of .70, limiting the confidence we can place in those results. Future research should explore whether this negative relationship between case combination and originality is specific to certain types of cases, particularly expert-generated, external ones. It is possible that novices lack the domain expertise required to integrate and extend expert examples, instead relying heavily on the source material, which could limit originality. This may not be the case for personal cases, with which participants are more familiar and potentially more flexible. Ultimately, these findings contribute to the ongoing debate in creativity research regarding the trade-off between idea quality and originality. While the ideal creative solution is both novel and useful (Amabile, 1996), studies suggest that ideas often tend to be one or the other (Ostermaier & Uhl, 2020), with organizations frequently prioritizing feasibility over originality (Berg, 2014). Our study raises the possibility that case-based combination may enhance quality at the expense of originality, an important consideration for creativity training and innovation practices.

General Discussion

Limitations

Before turning to implications, future directions and conclusions, it is important to acknowledge certain limitations of this study. First, the inter-rater reliability (IRR) coefficient for solution originality in Study 1 was lower than ideal (.63). While this aligns with previous findings that originality is difficult to evaluate and that individuals often struggle to accurately assess idea novelty (Blair & Mumford, 2007; Licuanan et al., 2007), it may have contributed to the lack of significant findings for plan originality in that study. Moreover, the low IRR complicated interpretation in Study 2, particularly regarding whether the observed negative relationship between conceptual combination effectiveness and plan originality was a true effect or an artifact. Although a significant positive correlation between these variables was found in Study 1, the low

reliability prevents confident interpretation. During the frame-of-reference training, it became evident that raters' originality judgments were influenced by their own high school experiences (e.g., cutting-edge vs. traditional projects). However, raters appeared to calibrate over time, achieving high IRR for this variable in Study 2. Second,, conceptual combination was examined using a real-world task with an undergraduate sample. As a result, caution should be exercised when generalizing these findings to other populations (e.g., non-college-attending individuals) or to more complex forms of creative performance. Additionally, the study focused on conceptual combination within a specific domain, designing educational curricula, a complex socio-technical system. This type of problem-solving task was chosen because prior research (Mumford et al., 2003; Scott et al., 2005) suggests that case-based approaches are well-suited for solving such problems. Given the study's objectives, this was a necessary choice. However, it is important to recognize that these findings may not directly apply to other types of conceptual combination tasks across different domains (e.g., product development). Further research is needed to determine whether similar patterns hold in other contexts. Despite these limitations, our studies provide noteworthy contributions to theory and practice.

Theoretical and Practical Implications

These studies enhance our understanding of creativity by demonstrating that the source of prior cases, whether personal or external, plays a crucial role in conceptual combination effectiveness and creative performance among non-experts. While existing research acknowledges the importance of prior cases in creative problem-solving for individuals with low-to-moderate expertise (Hunter et al., 2008; Scott et al., 2005), our findings refine this perspective by showing that these individuals benefit more from using external expert cases than personal experiences. This supports theories of expertise, which suggest that experts develop structured mental representations of their experiences, while non-experts often struggle with unorganized or biased

recall (Baer, 2015; Weisberg, 2015). Additionally, our findings raise questions about a potential trade-off between quality and originality when non-experts work with external expert cases. While conceptual combination effectiveness improved solution quality and elegance, it negatively impacted originality in study 2. This suggests that when individuals rely heavily on structured case integration, they may inadvertently limit their ability to generate novel solutions.

Furthermore, this study provides further support for the role of heuristic guidance in creative thinking. While heuristics guidance did not directly improve creative performance, it did so indirectly via enhancing conceptual combination effectiveness. This suggests that structured problem-solving techniques may enhance the processes involved in creative thinking, such as organizing and refining ideas, without necessarily promoting breakthrough innovation as an end product. Rather, their value may lie in indirectly supporting superior creative outcomes by optimizing the pathways that lead to them. In light of the mixed evidence surrounding heuristic training in creativity (Mulhearn et al., 2020), these findings point to the need for a more nuanced understanding of how structured guidance and the origin of knowledge, whether personal or external, work together to shape creative outcomes.

These findings also have important practical implications for organizations seeking to enhance creativity among employees with low-to-moderate expertise. Given that external cases proved more effective than personal experiences for non-experts, organizations should consider developing expert case libraries, best practice repositories, and expert-driven knowledge-sharing platforms. These resources could help non-expert employees generate higher-quality solutions, particularly in fields requiring complex problem-solving, such as healthcare, education, and technology. However, it is equally important to pair these resources with heuristic guidance to help employees effectively combine elements from different cases. This guidance should emphasize the

need to thoughtfully adapt, rather than directly replicate case content to suit the current problem, thereby promoting solution quality while preserving originality.

Additionally, when external cases are unavailable, individuals with no deep expertise in the problem domain should apply their most relevant and successful problem-solving moments that elicit positive emotions. Training programs could incorporate structured reflection exercises to help employees extract key insights from successful past experiences and apply them strategically to new challenges. Overall, this study advances the creativity literature by demonstrating how case source, case features and heuristic guidance influence conceptual combination effectiveness, offering practical recommendations for organizations seeking to optimize knowledge use and creativity training.

Future Directions

Future research should extend the current findings by examining the effects of case source and heuristic guidance on conceptual combination effectiveness and creative performance of experts. Given that experts have more structured and well-integrated personal experiences, the distinction between their own cases and external expert cases may diminish. As a result, the impact of case source on conceptual combination effectiveness could be reduced. However, since personal experiences are often shaped by cognitive biases (e.g., “if all you have is a hammer, everything looks like a nail”), it remains an open question whether experts, like non-experts, might still benefit from external cases to counteract these biases. Investigating this within an expert sample would provide valuable insights into how experience level influences case-based creativity.

Another important direction is to explore whether case-based conceptual combination inherently constrains originality and what additional cognitive mechanisms might help balance structure with novelty in creative problem-solving. It would also be interesting to see if that is particularly the case for non-experts working with external expert cases, as they may be mimicking

these past solutions too closely without attending to the nuances of the new problem. Additionally, further research should examine whether the same features that enhance the usefulness of personal cases—such as successful outcomes and positive emotions—also apply to external expert cases, or whether different factors are at play. Given the mixed findings in the literature, clarifying what makes external cases most effective could help optimize case-based approaches for fostering creativity.

Conclusions

This study aimed to provide evidence supporting the use of external expert cases and heuristic guidance in case-based conceptual combination among non-experts. Our findings demonstrate that individuals with low to moderate domain expertise benefit significantly from working with expert-provided cases, particularly when guided on how to effectively combine elements to develop high-quality and elegant solutions to complex socio-technical problems. Additionally, when external cases are unavailable, our results suggest that non-experts should draw from personal experiences that involve successful outcomes and positive emotions, as these contribute to better creative performance. This study also challenges the widely assumed positive relationship between case-based conceptual combination effectiveness and solution originality. Our findings suggest a potential trade-off, raising important questions about how a well-established process in creative thinking might, under certain conditions, hinder originality. Future research should explore these contradictions to better understand the nuances of conceptual combination in the creative process.

References

Amabile, T. M., Conti, R., Coon, H., Lazenby, J., & Herron, M. (1996). Assessing the work environment for creativity. *Academy of management journal, 39*(5), 1154-1184.

Amabile, T. M., & Conti, R. (1999). Changes in the work environment for creativity during downsizing. *Academy of Management Journal, 42*(6), 630-640.

Argote, L., & Ingram, P. (2000). Knowledge transfer: A basis for competitive advantage in firms. *Organizational Behavior and Human Decision Processes, 82*(1), 150-169.

Argote, L., & Todorova, G. (2007). Organizational learning: Review and future directions. In G. P. Hodgkinson & J. K. Ford (Eds.), *International review of industrial and organizational psychology*, *22*, 193-234. Wiley.

Antes, A. L., & Mumford, M. D. (2012). Strategies for leader cognition: Viewing the glass "half full" and "half empty". *The Leadership Quarterly*, *23*(3), 425-442.

Antes, A. L., Thiel, C. E., Martin, L. E., Stenmark, C. K., Connelly, S., Devenport, L. D., & Mumford, M. D. (2012). Applying cases to solve ethical problems: The significance of positive and process-oriented reflection. *Ethics & Behavior, 22*(2), 113-130.

Atkinson, T. N. (2008). Using creative writing techniques to enhance the case study method in research integrity and ethics courses. *Journal of Academic Ethics, 6*, 33-50.

Baer, J. (2003). The impact of group brainstorming on creative thinking: A meta-analysis. *Journal of Creative Behavior, 37*(1), 1-28.

Baer, J. (2015). *The importance of domain-specific expertise in creativity*. Academic Press.

Baas, M., De Dreu, C. K. W., & Nijstad, B. A. (2008). A meta-analysis of 25 years of mood-creativity research: Hedonic tone, activation, or regulatory focus? *Psychological Bulletin, 134*(6), 779-806.

Bagdasarov, Z., Harkrider, L. N., Johnson, J. F., MacDougall, A. E., Devenport, L. D., Connelly, S., Mumford, M. D., & Thiel, C. E. (2012). An investigation of case-based instructional strategies on learning, retention, and ethical decision-making. *Journal of Empirical Research on Human Research Ethics, 7*(4), 79-86.

Bagdasarov, Z., Connelly, S., & Mumford, M. D. (2013). Cognitive capacity and emotional intelligence in ethical decision making: The importance of timing. *Ethics & Behavior, 23*(4), 319-336.

Baddeley, A. (2000). The episodic buffer: A new component of working memory? *Trends in Cognitive Sciences, 4*(11), 417-423.

Bandura, A. (1977). Self-efficacy: Toward a unifying theory of behavioral change. *Psychological Review, 84*(2), 191-215.

Baughman, W. A., & Mumford, M. D. (1995). Process-analytic models of creative capacities: Operations influencing the combination-and-reorganization process. *Creativity Research Journal, 8*(1), 37-62.

Berg, J. M. (2014). The primal mark: How the beginning shapes the end in the development of creative ideas. *Organizational Behavior and Human Decision Processes, 125*(1), 1-17.

Besemer, S. P., & O'Quin, K. (1999). Confirming the three-factor creative product analysis matrix model in an American sample. *Creativity Research Journal, 12*(4), 287-296.

Blair, C. A., & Mumford, M. D. (2007). Errors in idea evaluation: Preference for the unoriginal? *The Journal of Creative Behavior, 41*(3), 197-222.

Brem, A., Puente-Díaz, R., & Agogué, M. (2016). Creativity and innovation: State of the art and future perspectives for research. *International Journal of Innovation Management, 20*(4), 1602001.

Bruner, J. S., Goodnow, J. J., & Austin, G. A. (1955). *A study of thinking*. Wiley.

Cacioppo, J. T., Petty, R. E., & Kao, C. F. (1984). The efficient assessment of need for cognition. *Journal of Personality Assessment, 48*(3), 306-307.

Connelly, S., Gilbert, J. A., Zaccaro, S. J., Threlfall, K. V., Marks, M. A., & Mumford, M. D. (2000). Exploring the relationship of leadership skills and knowledge to leader performance. *The Leadership Quarterly, 11*(1), 65-86.

Connelly, S., & Ruark, G. A. (2010). Leadership style and activating potential moderators of the relationships among leader emotional displays and outcomes. *The Leadership Quarterly, 21*(5), 745-764.

Conner, T. S., & Silvia, P. J. (2015). Creative days: A daily diary study of emotion, personality, and everyday creativity. *Psychology of Aesthetics, Creativity, and the Arts, 9*(4), 463-470.

Damasio, A. R. (2001). *Fundamental feelings*. Nature, 413(6858), 781.

D'Argembeau, A., & Van der Linden, M. (2007). Facial expressions of emotion influence memory for facial identity in an automatic way. *Emotion, 7*(3), 507.

Dietrich, A. (2004). The cognitive neuroscience of creativity. *Psychonomic Bulletin & Review, 11*(6), 1011–1026.

Estes, Z., & Ward, T. B. (2002). The emergence of novel attributes in concept modification. *Creativity Research Journal, 14*(2), 149-156.

Fiedler, K., & Garcia, M. (1987). The impact of evaluative mood on memory. *Cognition & Emotion, 1*(1), 77–98.

Finke, R. A., Ward, T. B., & Smith, S. M. (1992). *Creative cognition: Theory, research, and applications.* MIT Press.

Flaherty, A. W. (2005). Frontotemporal and dopaminergic control of idea generation and creative drive. *The Journal of Comparative Neurology, 493*(1), 147–153.

Fredrickson, B. L. (2004). The broaden-and-build theory of positive emotions. *Philosophical Transactions of the Royal Society B: Biological Sciences, 359*(1449), 1367–1377.

Frensch, P. A., & Sternberg, R. J. (1989). Expertise and intelligent thinking: When is it worse to know better? In *R. J. Sternberg (Ed.), Advances in the psychology of human intelligence*, *5*, 157–188. Erlbaum.

Friedrich, T. L., & Mumford, M. D. (2009). The effects of conflicting information on creative thought: A source of performance improvements or decrements? *Creativity Research Journal, 21*(2-3), 265-281.

George, J. M., & Zhou, J. (2002). Understanding when bad moods foster creativity and good ones don't: The role of context and clarity of feelings. *Journal of Applied Psychology, 87*(4), 687–697.

Gill, T., & Dube, L. (2007). What is a leather iron or a bird phone? Using conceptual combinations to generate and understand new product concepts. *Journal of Consumer Psychology, 17*(3), 202-217.

Gill, C. M., & Hodgkinson, G. P. (2007). Development and validation of the five-factor model questionnaire (FFMQ): An adjectival-based personality inventory for use in occupational settings 1. *Personnel Psychology, 60*(3), 731-766.

Gino, F., Argote, L., Miron-Spektor, E., & Todorova, G. (2010). First, get your feet wet: The effects of learning from direct and indirect experience on team creativity. *Organizational behavior and human decision processes, 111*(2), 102-115.

Greene, J. D., Sommerville, R. B., Nystrom, L. E., Darley, J. M., & Cohen, J. D. (2001). An fMRI investigation of emotional engagement in moral judgment. *Science, 293*(5537), 2105–2108.

Grimsley, G., Ruch, F. L., Warren, N. D., & Ford, J. S. (1985). Employee aptitude survey, test 7 Verbal reasoning. *Psychological Services, Inc*.

Harkrider, L. N., Thiel, C. E., Bagdasarov, Z., Mumford, M. D., Johnson, J. F., Connelly, S., & Devenport, L. D. (2012). Improving case-based ethics training with codes of conduct and forecasting content. *Ethics & Behavior*, *22*(4), 258-280.

Haven, K. (2007). *Story proof: The science behind the startling power of story*. Bloomsbury Publishing USA.

Hayes, A. F., & Preacher, K. J. (2010). Quantifying and testing indirect effects in simple mediation models when the constituent paths are nonlinear. *Multivariate behavioral research*, *45*(4), 627-660.

Herreid, C. F. (1997). What makes a good case. *Journal of college science teaching*, *27*(3).

Hennessey, B.A., & Amabile, T.M. (2010). Creativity. *Annual Review of Psychology, 61*, 569–598.

Hunter, S. T., Bedell-Avers, K. E., Hunsicker, C. M., Mumford, M. D., & Ligon, G. S. (2008). Applying multiple knowledge structures in creative thought: Effects on idea generation and problem-solving. *Creativity Research Journal*, *20*(2), 137-154.

Isen, A. M., Johnson, M., Mertz, E., & Robinson, G. F. (1985). The influence of positive affect on the unusualness of word associations. *Journal of personality and social psychology*, *48*(6), 1413.

Isen, A. M. (1987). Positive affect, cognitive processes, and social behavior. In *Advances in experimental social psychology* (Vol. 20, pp. 203-253). Academic Press.

Johnson, J. F., Bagdasarov, Z., Connelly, S., Harkrider, L., Devenport, L. D., Mumford, M. D., & Thiel, C. E. (2012). Case-based ethics education: The impact of cause complexity and outcome favorability on ethicality. *Journal of Empirical Research on Human Research Ethics*, *7*(3), 63-77.

Sternberg, R. J., Kaufman, J. C., & Roberts, A. M. (2019). 16 The relation of creativity to intelligence and wisdom. *The Cambridge handbook of creativity*, 337-352.

Kim, Y., & Baylor, A. L. (2006). A social-cognitive framework for pedagogical agents as learning companions. *Educational technology research and development*, *54*, 569-596.

Klijn, M., & Tomic, W. (2010). A review of creativity within organizations from a psychological perspective. *Journal of Management Development,* 322-343.

Kohn, N. W., Paulus, P. B., & Korde, R. M. (2011). Conceptual combinations and subsequent creativity. *Creativity Research Journal*, *23*(3), 203-210.

Kolodner, J. L. (1993, November). Understanding creativity: A case-based approach. In *European Workshop on case-based reasoning* (pp. 1-20). Berlin, Heidelberg: Springer Berlin Heidelberg.

Koplinka, L., Brandan, R., & Lemmon, A. (1988). Case-based reasoning for continuous control. In J. L. Kolodner (Ed.) *Proceedings: Workshop on case-based reasoning* (pp. 116–136). San Mateo, CA: Morgan Kaufman.

Kucharska, W., & Erickson, G. S. (2023). Tacit knowledge acquisition & sharing, and its influence on innovations: A Polish/US cross-country study. *International Journal of Information Management*, *71*, 102647.

Licuanan, B. F., Dailey, L. R., & Mumford, M. D. (2007). Idea evaluation: Error in evaluating highly original ideas. *The Journal of Creative Behavior*, *41*(1), 1-27.

Lonergan, D. C., Scott, G. M., & Mumford, M. D. (2004). Evaluative aspects of creative thought: Effects of appraisal and revision standards. *Creativity Research Journal*, *16*(2-3), 231-246.

Lynott, D., & Connell, L. (2010). Embodied conceptual combination. *Frontiers in Psychology*, *1*, 212.

MacKinnon, D. W. (1962). The nature and nurture of creative talent. *American psychologist*, *17*(7), 484.

Mahoney, J. L., Weissberg, R. P., Greenberg, M. T., Dusenbury, L., Jagers, R. J., Niemi, K., Schlinger, M., Schlund, J., Shriver, T. P., VanAusdal, K., & Yoder, N. (2020). Systemic Social and Emotional Learning: Promoting Educational Success for All Preschool to High School Students. *American Psychologist.* Advance online publication.

McCrae, R. R. (1987). Creativity, divergent thinking, and openness to experience. *Journal of personality and social psychology*, *52*(6), 1258.

Mednick, M. T., Mednick, S. A., & Mednick, E. V. (1964). Incubation of creative performance and specific associative priming. *The Journal of Abnormal and Social Psychology*, *69*(1), 84.

Merrifield, P. R., Guilford, J. P., Christensen, P. R., & Frick, J. W. (1962). The role of intellectual factors in problem solving. *Psychological Monographs: General and Applied*, *76*(10), 1.

Mitchell, D. (2008). What Really Works in Special and Inclusive Education. *Using evidence-based teaching strategies.* London & New York. Routledge.

Mitchell, D., Keese, J., Banerjee, M., Huston, D., & Kwok, A. (2021). Induction experiences of novice teachers and their coaches. *Teacher Development*, *25*(4), 411–431.

Mitchell, D., & Sutherland, D. (2020). *What really works in special and inclusive education: Using evidence-based teaching strategies*. Routledge.

Mobley, M. I., Doares, L. M., & Mumford, M. D. (1992). Process analytic models of creative capacities: Evidence for the combination and reorganization process. *Creativity Research Journal*, *5*(2), 125-155.

Mulhearn, T. J., McIntosh, T., & Mumford, M. D. (2020). Reflecting on the past, looking towards the future: The effects of case analysis on forecasting. *Creativity Research Journal*, *32*(3), 299-312.

Mumford, M. D. (2000). Managing creative people: Strategies and tactics for innovation. *Human resource management review*, *10*(3), 313-351.

Mumford, M. D. (2002). Social innovation: ten cases from Benjamin Franklin. *Creativity research journal*, *14*(2), 253-266.

Mumford, M. D., Mobley, M. I., Reiter-Palmon, R., Uhlman, C. E., & Doares, L. M. (1991). Process analytic models of creative capacities. *Creativity research journal*, *4*(2), 91-122.

Mumford, M. D., Baughman, W. A., Maher, M. A., Costanza, D. P., & Supinski, E. P. (1997). Process-based measures of creative problem-solving skills: IV. Category combination. *Creativity Research Journal*, *10*(1), 59-71.

Mumford, M. D., Connelly, S., & Gaddis, B. (2003). How creative leaders think: Experimental findings and cases. *The Leadership Quarterly, 14*(4-5), 411-432.

Mumford, M. D., Baughman, W. A., Supinski, E. P., & Maher, M. A. (1996). Process-based measures of creative problem-solving skills: II. Information encoding. *Creativity Research Journal*, *9*(1), 77-88.

Mumford, M. D., Blair, C., Dailey, L., Leritz, L. E., & Osburn, H. K. (2006). Errors in creative thought? Cognitive biases in a complex processing activity. *The Journal of Creative Behavior, 40*(2), 75-109.

Mumford, M. D., Hester, K. S., & Robledo, I. C. (2012). Creativity in organizations: Importance and approaches. In *Handbook of organizational creativity* (pp. 3-16). Academic Press.

Mumford, M. D., Giorgini, V., Gibson, C., & Mecca, J. (2013). Creative thinking: Processes, strategies and knowledge. In *Handbook of research on creativity* (pp. 249-264). Edward Elgar Publishing.

Mumford, M. D., & England, S. (2022). The future of creativity research: Where are we, and where should we go. *Journal of Creativity*, *32*(3), 100034.

Mumford, M. D., & Gustafson, S. B. (1988). Creativity syndrome: Integration, application, and innovation. *Psychological bulletin*, *103*(1), 27.

Mumford, M. D., & McIntosh, T. (2017). Creative thinking processes: The past and the future. *The Journal of Creative Behavior*, *51*(4), 317-322.

Nonaka, L., Takeuchi, H., & Umemoto, K. (1996). A theory of organizational knowledge creation. *International journal of technology Management*, *11*(7-8), 833-845.

Osburn, H. K., & Mumford, M. D. (2006). Creativity and planning: Training interventions to develop creative problem-solving skills. *Creativity Research Journal*, *18*(2), 173-190.

Ostermaier, A., & Uhl, M. (2020). Performance evaluation and creativity: Balancing originality and usefulness. *Journal of Behavioral and Experimental Economics*, *86*, 101552.

Philbin, T. (2005). *The 100 greatest inventions of all time: A ranking past and present*. Citadel Press.

Reilly, R. C. (2008). Is expertise a necessary precondition for creativity? A case of four novice learning group facilitators. *Thinking skills and creativity*, *3*(1), 59-76.

Reeves, L., & Weisberg, R. W. (1994). The role of content and abstract information in analogical transfer. *Psychological bulletin*, *115*(3), 381.

Reiter-Palmon, R., Mumford, M. D., & Threlfall, K. V. (1998). Solving everyday problems creatively: The role of problem construction and personality type. *Creativity Research Journal*, *11*(3), 187-197.

Rich, J. D., & Weisberg, R. W. (2004). Creating all in the family: A case study in creative thinking. *Creativity Research Journal*, *16*(2-3), 247-259.

Ruch, F. L., & Ruch, W. W. (1963). *Employee aptitude survey: Technical report*. Los Angeles: Psychological Services.

Runco, M. A. (2004). Everyone has creative potential.

Scott, G., Leritz, L. E., & Mumford, M. D. (2004). Types of creativity training: Approaches and their effectiveness. *The Journal of Creative Behavior*, *38*(3), 149-179.

Scott, G. M., Lonergan, D. C., & Mumford, M. D. (2005). Conceptual combination: Alternative knowledge structures, alternative heuristics. *Creativity Research Journal*, *17*(1), 79-98.

Sedikides, C., & Green, J. D. (2004). What I don't recall can't hurt me: Information negativity versus information inconsistency as determinants of memorial self-defense. *Social cognition*, *22*(1: Special issue), 4-29.

Sternberg, R. J., & Lubart, T. I. (1995). *Defying the crowd: Cultivating creativity in a culture of conformity*. Free press.

Strasbaugh, K., & Connelly, S. (2022). The influence of anger and anxiety on idea generation: Taking a closer look at integral and incidental emotion effects. *Psychology of Aesthetics, Creativity, and the Arts*, *16*(3), 529.

Strange, J. M., & Mumford, M. D. (2005). The origins of vision: Effects of reflection, models, and analysis. *The Leadership Quarterly*, *16*(1), 121-148.

Sullivan, M. J., & Conway, M. (1989). Negative affect leads to low-effort cognition: Attributional processing for observed social behavior. *Social Cognition*, *7*(4), 315-337.

Thomas, J. B., & McDaniel Jr, R. R. (1990). Interpreting strategic issues: Effects of strategy and the information-processing structure of top management teams. *Academy of Management journal*, *33*(2), 286-306.

Thiel, C. E., Connelly, S., & Griffith, J. A. (2011). The influence of anger on ethical decision making: Comparison of a primary and secondary appraisal. *Ethics & Behavior*, *21*(5), 380-403.

Tien, H. K., Chang, B. L., & Kuo, Y. K. (2019). Does experience stimulate or stifle creativity? *European Journal of Innovation Management*, *22*(3), 422-445.

To, M. L., Fisher, C. D., Ashkanasy, N. M., & Rowe, P. A. (2012). Within-person relationships between mood and creativity. *Journal of Applied Psychology*, *97*(3), 599.

Usher, M., Cohen, J. D., Servan-Schreiber, D., Rajkowski, J., & Aston-Jones, G. (1999). The role of locus coeruleus in the regulation of cognitive performance. *Science*, *283*(5401), 549-554.

Vincent, A. S., Decker, B. P., & Mumford, M. D. (2002). Divergent thinking, intelligence, and expertise: A test of alternative models. *Creativity research journal*, *14*(2), 163-178.

Vessey, W. B., & Mumford, M. D. (2012). Heuristics as a basis for assessing creative potential: Measures, methods, and contingencies. *Creativity Research Journal*, *24*(1), 41-54.

Vessey, W. B., Barrett, J., & Mumford, M. D. (2011). Leader cognition under threat: "Just the Facts". *The Leadership Quarterly*, *22*(4), 710-728.

Watts, L. L., Steele, L. M., & Song, H. (2017). Re-examining the relationship between need for cognition and creativity: Predicting creative problem solving across multiple domains. *Creativity Research Journal*, *29*(1), 21-28.

Weisberg, R. W. (2006). Expertise and reason in creative thinking. *Creativity and reason in cognitive development*, 7-42.

Weisberg, R. W. (2015). Expertise, nonobvious creativity, and ordinary thinking in Edison and others: Integrating blindness and sightedness. *Psychology of Aesthetics, Creativity, and the Arts*, *9*(1), 15.

Wilkenfeld, M. J., & Ward, T. B. (2001). Similarity and emergence in conceptual combination. *Journal of Memory and Language*, *45*(1), 21-38.

Wu, L. L., & Barsalou, L. W. (2009). Perceptual simulation in conceptual combination: Evidence from property generation. *Acta Psychologica*, *132*(2), 173-189.

Yeh, W., & Barsalou, L. W. (2006). The situated nature of concepts. *The American journal of psychology*, *119*(3), 349-384.

Tables and Figures

Table 1

Intercorrelations and Descriptive Statistics for Study 1 Variables

	M	*SD*	1	2	3	4	5	6	7	8	9	10	11	12	13	14
1. Negative Outcomes	2.73	1.24	(.74)													
2. Positive Outcomes	2.95	1.23	-.54**	(.73)												
3. Pos. Act. Emotions	2.62	1.20	-.52**	.92**	(.75)											
4. Pos. Deac. Emotions	2.05	.94	-.49**	.81**	.78**	(.78)										
5. Neg. Act. Emotions	2.19	1.05	.81**	-.44**	-.40**	-.35**	(.74)									
6. Neg. Deac. Emotions	2.14	1.02	.86**	-.50**	-.44**	-.45**	.77**	(.77)								
7. Similarity	2.64	1.07	-.01	0.06	.05	.18	-.04	.02	(.71)							
8. Conceptual Combination Effectiveness	12.18	3.43	-.03	.31**	.27*	.24*	.03	-.05	.09	(.76)						
9. Plan Quality	2.96	.88	.18	.21	.13	.08	.14	.21	.06	.54**	(.77)					
10. Plan Originality	2.79	1.00	.04	.10	.07	.06	-.02	.00	-.07	.38**	.78**	(.63)				
11. Plan Elegance	2.90	.93	.15	.31**	.26*	.22*	.14	.17	.09	.53**	.86**	.64**	(.73)			
Covariates																
12. GPA	3.38	.54	.01	.21	.24*	.21	.03	.02	.09	.29**	.30**	.14	.32*			
13. Intelligence	23.79	5.99	-.01	.12	.14	.16	-.05	.01	.17	.09	.35**	.26*	.37**	.07		
14. Neuroticism	48.60	7.42	.08	-.09	-.06	-.08	.14	.07	.07	-.05	-.20	-.22*	-.28**	-.11	-.07	
15. English Proficiency	1.99	.42	-.03	-.06	-.06	-.12	-.06	-.08	-.20	-.06	-.21	-.16	-.24*	-.03	-.06	-.04

Note. N = 84. **p < .01, *p < .05. Interrater reliability is in parentheses on the diagonal where applicable. Only covariates with a significant zero-order correlation with the outcome variables are included in the table.

Table 2

Regression Analyses for Study 1

	Conceptual Combination Effectiveness				Plan Quality				Plan Originality				Plan Elegance			
	Model 1		Model 2		Model 1		Model 2		Model 1		Model 2		Model 1		Model 2	
	SE	Beta	*SE*	Beta	*SE*	Beta	*SE*	Beta	*SE*	Beta	*SE*	Beta	*SE*	Beta	*SE*	Beta
Covariates																
GPA	.69	.29**	.71	.21												
Intelligence					.02	.35**	.01	.33**	.02	.27*	.02	.27*	.02	.34**	.01	.30**
English Proficiency													.21	-.23*	.19	-.19*
Neuroticism													.01	-.27**	.01	-.27*
Predictors																
Positive Outcomes			.83	.49			.19	.92**			.25	.20			.18	.73**
Negative Outcomes			.69	.10			.16	.04			.21	.25			.15	.16
Positive Act. Emotions			.79	-.11			.18	-.39			.24	-.07			.17	-.15
Positive Deac. Emotions			.70	-.05			.16	-.23			.21	-.03			.16	-.16
Negative Act. Emotions			.63	.16			.14	.06			.19	-.11			.14	.14
Negative Deac. Emotions			.74	-.08			.17	.32			.22	-.08			.16	.16
Similarity			.35	.05			.08	.00			.11	-.12			.08	.01
Model Summary																
R^2		.08**		.19*		12**		.32**		.07*		.10		.26**		.46**
R^2change				.10				.19**				.04				.20**

Note: $N = 263$. $^{**}p < .01$, $^{*}p < .05$. Only covariates with a significant zero-order correlation with the outcome variables were included in the models.

Table 3

Intercorrelations and Descriptive Statistics for Study 2 Variables

	M	*SD*	1	2	3	4	5
1. Conceptual Combination Effectiveness	9.95	3.67	(.75)				
2. Plan Quality	2.50	.69	.43**	(.80)			
3. Plan Originality	2.31	.61	-.13*	.20**	(.74)		
4. Plan Elegance	2.48	.62	.39**	.82**	.33**	(.77)	
Control Variables							
5. Need for Cognition	56.39	10.70	.04	.18**	.01	.14*	
6. Conscientiousness	57.27	8.77	.07	.14*	.01	.14*	.20*

Note: $N = 263$. **$p < .01$, *$p < .05$. Interrater reliability is in parentheses on the diagonal where applicable. Only covariates with a significant zero-order correlation with the outcome variables are included in the table.

Table 4

Descriptive Statistics by Condition for Study 2 Outcomes

Case Source	Heuristics	Conceptual Combination Effectiveness		Plan Quality		Plan Originality		Plan Elegance	
		M	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*
Personal	No Guidance	8.59	3.28	2.53	.90	2.36	.58	2.55	.86
	Guidance	10.24	3.00	2.43	.57	2.13	.47	2.43	.56
External	No Guidance	10.21	3.54	2.56	.70	2.34	.67	2.46	.58
	Guidance	10.85	4.16	2.54	.62	2.37	.70	2.52	.54
Mix	No Guidance	9.07	3.74	2.51	.68	2.27	.50	2.42	.45
	Guidance	10.66	3.81	2.44	.68	2.38	.70	2.44	.66

Note: N = 263. Not adjusted for covariates

Table 5

Path Coefficients and Indirect Effects Mediation Models with Case Source as the Predictor

				95% *CI*	
	b	*SE*	β	Lower	Upper
Model 1 Total Effects					
CS1 → PLANQ	.07	.10	.05	-.154	.248
CS2 → PLANQ	.01	.10	.01	-.197	.215
NFG → PLANQ	.18**	.00	.01	.004	.019
Model 2 Total Effects					
CS1 → PLANO	.18	.09	.11	-.066	.292
CS2 → PLANO	.14	.09	.09	-.096	.272
Model 3 Total Effects					
CS1 → PLANE	.01	.09	.00	-.177	.184
CS2 → PLANE	-.10	.09	-.06	-.248	.124
Conscient → PLANE	.14*	.00	.01	.002	.019
Model 1 Indirect Effects					
CS1 → CCE → PLANQ	.13*	.05	.09	.006	.182
CS2 → CCE → PLANQ	.06	.04	.04	-.045	.129
Model 2 Indirect Effects					
CS1 → CCE → PLANO	-.04*	.02	-.03	-.063	-.002
CS2 → CCE → PLANO	-.02	.01	-.01	-.044	.016
Model 3 Indirect Effects					
CS1 → CCE → PLANE	.12*	.04	.08	.007	.150
CS2 → CCE → PLANE	-.07	.04	-.04	-.122	.033
Model 1 Path Coefficients					
CS1 → CCE	.30*	.54	1.12	.046	2.192
CS2 → CCE	.13	.56	.49	-.607	1.592
CCE → PLANQ	.42**	.01	.08	.059	.101
Model 2 Path Coefficients					
CS1 → CCE	.31*	.54	1.14	.075	2.210
CS2 → CCE	.13	.56	.48	-.617	1.577
CCE → PLANO	-.14*	.01	-.02	-.045	-.004
Model 3 Path Coefficients					
CS1 → CCE	.31*	.54	1.14	.076	2.209
CS2 → CCE	-.18	.56	-.66	-1.758	.445
CCE → PLANE	.39**	.01	.06	.046	.084
Model 1 Direct Effects					
CS1 → PLANQ	-.06	.09	-.04	-.226	.141
CS2 → PLANQ	-.04	.10	-.03	-.217	.157
Model 2 Direct Effects					
CS1 → PLANO	.23	.09	.14	-.038	.320
CS2 → PLANO	.16	.09	.10	-.082	.283
Model 3 Direct Effects					
CS1 → PLANE	-.11	.08	-.07	-.239	.097
CS2 → PLANE	.03	.09	-.02	-.192	.153

Note: N = 263. ***p* < .01, **p* < .05. CS1 – case source: 0 = internal, 1 = external, CS2 – case source: 0 = internal, 1 = mixed, NFC – need for cognition, Conscient – conscientiousness, PLANQ – plan quality, PLANO – plan originality, PLANE – plan elegance

Table 6

Path Coefficients and Indirect Effects Mediation Models with Heuristics as the Predictor

				95% *CI*	
	b	*SE*	β	Lower	Upper
Model 4 Total Effects					
HEURISTICS → PLANQ	-.07	.08	-.05	-.213	.120
NFG → PLANQ	.18**	.00	.01	.004	.019
Model 5 Total Effects					
HEURISTICS → PLANO	-.05	.08	-.03	-.181	.117
Model 6 Total Effects					
HEURISTICS → PLANE	-.04	.08	-.03	-.178	.123
Conscient → PLANE	.15*	.00	.01	.002	.019
Model 4 Indirect Effects					
HEURISTICS → CCE → PLANQ	.16*	.04	.11	.039	.196
Model 5 Indirect Effects					
HEURISTICS → CCE → PLANO	-.05*	.02	-.03	-.062	-.004
Model 6 Indirect Effects					
HEURISTICS → CCE → PLANE	.14*	.03	.09	.025	.154
Model 4 Path Coefficients					
HEURISTICS → CCE	.37**	.45	1.35	.464	2.227
CCE → PLANQ	.42**	.01	.08	.059	.101
Model 5 Path Coefficients					
HEURISTICS → CCE	.36*	.45	1.32	.442	2.202
CCE → PLANO	-.13*	.01	-.02	-.043	-.002
Model 6 Path Coefficients					
HEURISTICS → CCE	.35**	.45	1.29	.402	2.169
CCE → PLANE	.40**	.01	.07	.048	.086
Model 4 Direct Effects					
HEURISTICS → PLANQ	-.23*	.08	-.16	-.311	-.006
Model 5 Direct Effects					
HEURISTICS → PLANO	.00	.08	.00	-.154	.148
Model 6 Direct Effects					
HEURISTICS → PLANE	-.18	.07	-.11	-.255	.027

Note: N = 263. ***p* < .01, **p* < .05. HEURISTICS – case-based heuristic guidance: 0 = no guidance, 1 = guidance, NFC – need for cognition, Conscient – conscientiousness, PLANQ – plan quality, PLANO – plan originality, PLANE – plan elegance

Figure 1

The Creative Process Model by Mumford and colleagues (1991)

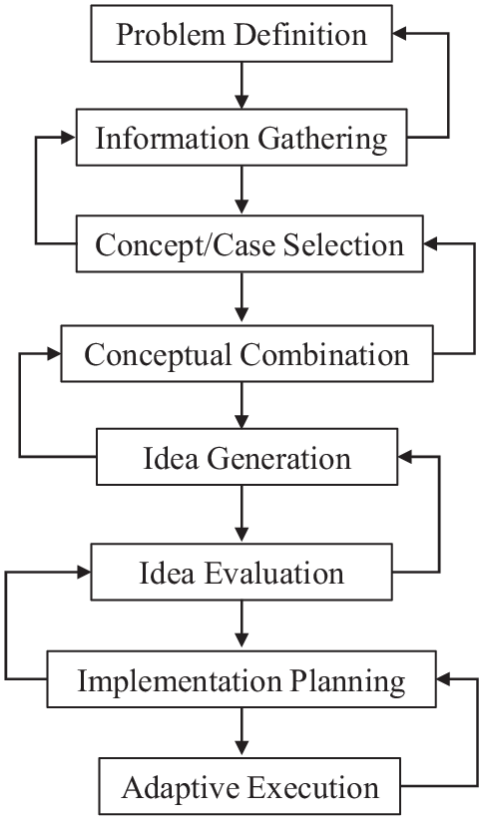


Figure 2

Example Personal Case

"*A thing that I feel my high school exceled at was providing multiple paths to success and garnering high levels of student achievement. My high school provided on level and honors courses in history, math, and micro/macroeconomics, it also provided students the ability to take dual credit college level classes in English and History. The ability to take dual credit classes helped me to feel more prepared for college and I was able to understand them more easily than the honors classes. I grew up in a very competitive place and my high school provided students with many different opportunities to get involved and strive for achievement and success*."

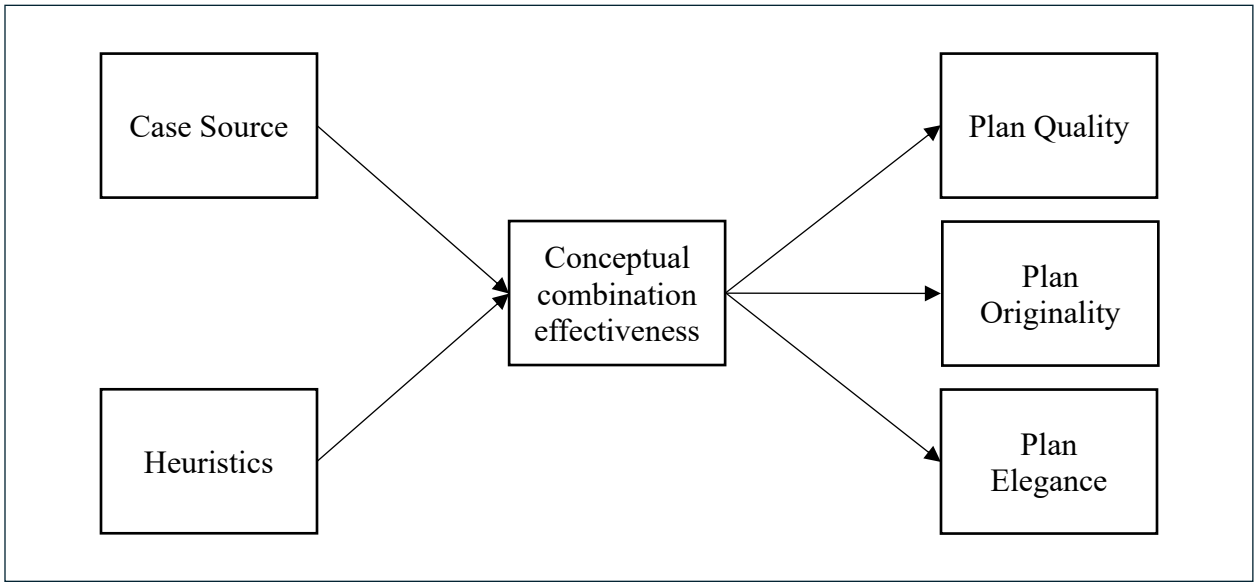
Figure 3

Example External Expert Case

External Case 1 – Cooperative Group Teaching		
Goals	**Content**	**Outcomes**
A primary objective of cooperative group teaching is to leverage the collective efforts of learners to attain outcomes surpassing what each individual could achieve alone. This teaching approach not only fosters collaborative learning but also cultivates virtues of mutual aid and compassion. Moreover, it has the potential to enhance community cohesion and foster a culture of respect for diversity.	Cooperative group teaching entails learners collaborating within small groups, supporting each other in both individual and collective tasks. In our implementation, we organized learners into groups comprising six to eight individuals, intentionally blending students with diverse abilities. The underlying principle was to harness the unique contributions of all learners, including those with special educational needs. To facilitate this, we structured "jigsaw" activities, wherein each group specialized in a specific facet of a topic and subsequently shared their expertise with the entire class upon mastering the material. For instance, in an activity centered on rainforest animals, one group focused on habitats while another on predators. In order to cultivate effective group dynamics, we prioritized imparting essential skills to the learners. These encompassed abilities such as active listening, maintaining eye contact, articulating ideas clearly, posing questions, making informed decisions, managing conflicts, offering encouragement, and embracing individual differences. Role-playing served as a valuable instructional method, wherein teachers engaged learners in various scenarios to demonstrate appropriate behavioral norms. Furthermore, diligent supervision of the groups was maintained, particularly those with learners exhibiting behavioral challenges. Regular feedback and positive reinforcement were provided to encourage desired behaviors and ensure the smooth functioning of the collaborative learning environment.	Participation in cooperative learning groups led to notable enhancements in mathematical, reading, and writing achievement scores among learners. Learners with special educational needs experienced significant gains from this collaborative learning approach. It is worth noting that high-achieving learners demonstrated greater achievements when placed in ability groups—comprising students with moderate to high abilities—compared to mixed-ability groups, which included both high and low achievers.

Figure 4

Conceptual Model of Mediational Analysis Conducted



Note: Covariates are not pictured but are included in analyses

Appendix A

Creative Problem-Solving Task

"Oklahoma Excel" High School

You have been appointed as the principal of the state's experimental school in Tulsa, Oklahoma 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 experimental school, and Tulsa's Oklahoma Excel School is Oklahoma's representation in the national study. The goal of each experimental state school is to develop and implement a new type of educational program that increases students' academic performance. At the end of the 2020-2021 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 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, mathematical 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 traditional Oklahoma 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 to spread the new curriculum around the state for comprehensive state scholastic improvement.

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 motivation for success because, last year, students in Oklahoma Public Schools ranked 47th nationally in academic performance on Standardized Tests. The state is also currently ranked 49th in funding for education. With these poor rankings in mind, you are determined to give students at Oklahoma Excel the best chance at success. Doing so would lead to exciting effects in Oklahoma and increase our state's national standing. Oklahoma Excel will be a High 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 principal 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. One problem the school currently faces is a lack of specialized education programs for students in special populations (i.e. gifted students and academically disabled students). In fact, several unsatisfied parents have opted for their children to attend other schools in the district due to a lack of education that tailors to their child's needs. In addition to unsatisfied parents, there has been a high level of turnover for teachers. Reasons for quitting have been reported to be due to the lack of opportunities for teachers to develop professionally and intellectually, burnout, low levels of autonomy in deciding the teaching curriculum, and overall general reports of low job satisfaction. In short, the school suffers from both unsatisfied teachers and unsatisfied parents. Therefore, in addition to improved test scores, teacher and parent satisfaction with the program will also be assessed to evaluate the success of your program.

Your Task

Your first task as Principal of Oklahoma Excel is to generate a plan on how to "achieve academic excellence." This plan should include several elements including teaching strategies, process improvement ideas, special activities, or programs, etc. To date, you have material that a team of teachers has gathered for you. This consists of a list of issues that teachers have found to be important to schools in different settings. You should review this material. Next, write a description of 2 prior experiences that are relevant in some way to the current situation and that you could use in producing a potential solution. Think of these as mini cases to draw from. Your job is to design a school instructional program that will encourage maximum proficiency in general education requirements from students at Oklahoma Excel.

List of Important Issues

Directions: Please read the following list of important issues and then use them when planning your program.

- Student Academic Learning
- Student Behavioral Conduct
- Positive Classroom Environment
- Resources to Accommodate Student Needs
- Differences in Students' Motivation and Capability
- Differences in Teacher Motivation and Capability
- Goals of the School
- Monitoring School Progress
- Professional Development of Teachers
- Parent-Community Involvement
- Teaching Programs Tailored to Student Needs
- Reasonable Disciplinary Actions
- Graduation Rate
- Parent Satisfaction
- Student Achievement
- Student Motivation
- Teacher Quality
- Multiple Paths to Success
- Diversity in All its Forms
- Student Autonomy in Learning
- Percentage of Students Who Go to College
- Advanced Degrees for Teachers
- Class Size

Previous Experiences (Cases)

Think of 2 past High School experiences that relate to the current issues and task at hand. Describe these cases in terms of the goals in that situation, the actions taken by you or others in this situation, the opportunities and/or challenges encountered and the outcomes of the situation. Be as specific and descriptive as you can, including how you and people involved felt about the situation.

Case-Based Reasoning Steps

Please, follow the following steps and write at least a few sentences for each.

1. Identify the most important aspects of both experiences that you described.
2. List the strengths and weaknesses of both experiences that you described.
3. Combine the strengths of both experiences to create a brief initial plan on how to achieve academic excellence.
4. Predict both the positive and negative outcomes of this brief initial plan if it was implemented.

Final Plan

Refer back to the notes that you just made and the information you have received to complete this next portion of the task. Your task as Principal of Oklahoma Excel is to generate a plan on how to "achieve academic excellence" in your "Excel" High School. This plan should include several elements including teaching strategies, process improvement ideas, special activities, or programs, etc. Fully elaborate your brief initial plan and write your final plan for your teaching method model. Be specific.

Appendix B

Benchmark Rating Scale for Case-Based Heuristics Step 1

Identify Key Characteristics: The extent to which the participant effectively identifies key characteristics of cases.
Markers:

- Key Goals – Does the participant state things characters were aiming for in the cases?
- Key Causes – Does the participant state things that made a difference in achieving results?
- Key Outcomes – Does the participant state things that were achieved?

1		**3**		**5**
Not at All Effective	2	*Somewhat Effective*	4	*Very Effective*

1 – The participant does not effectively identify key characteristics of cases. The participant does not mention nor emphasize the key goals, causes, and outcomes of the cases.
The participant provides no key aspects of the cases.

3 – The participant somewhat effectively identifies key characteristics of cases. The participant mentions or emphasizes some of the key goals, causes, or outcomes of the cases, but may be missing one or more of these key characteristics.
"From both rewards and smaller class sizes, students were able to have more motivation to complete work. They also increased the knowledge intake from what was being taught."

5 – The participant effectively identifies key characteristics of cases. The participant mentions and emphasizes all key goals, causes, and outcomes of the cases.
"In both of my experiences, I think the most important aspects are opportunity, the want to achieve, and the teachers. If the student does not want to work or take a hard class, they don´t want to take, they won´t learn, but the students that do, they will have the resources to do so. With that being said, one teacher can change a student´s outlook and drive them to success."

Appendix C

Benchmark Rating Scale for Plan Quality

Solution Quality: The extent to which the plan is logical, complete, and useful.
Markers:

- Logical – Is the plan coherent and reasonable (does it make sense)? Is it well thought out?
- Completeness – Is the plan comprehensive and does it address all the critical elements of the task?
- Usefulness – Is the plan a realistic and appropriate response for addressing the task?

1		**3**		**5**
Poor Quality	2	*Average Quality*	4	*Excellent Quality*

1 – The plan is of <u>poor quality</u>. The plan is illogical and incomplete. The key issues are not addressed. The plan was not well thought out and will not address the task at hand.
"My initial teaching method plan was to incorporate student freedom, needs, and communication with teachers. The original idea would be to provide training to both teachers and students on how to advocate for needs or change. Furthermore, it would be important to teach how to be respectful in doing this, and how to take criticism respectfully as well."

3 – The plan is of <u>average quality</u>. The plan addresses the task but may contain irrelevant elements. Most of the ideas are complete, the plan makes general sense overall and is likely to address the situation.
"The teaching method model I have come up with for academic excellence is to create a supportive and challenging environment. The teaching strategies used for students will be evidence based to ensure better results and this will be done by paying teachers a higher salary for knowing these techniques. The teachers will also meet students at their level to accommodate for the gifted students and academically disabled students, in separate classes. Programs for these students will be provided by trained teachers in these areas. The lessons and classroom policies will all address diversity in all forms to ensure a safe, inclusive, and welcoming environment for everybody to learn. There will be a team of leaders to delegate varies sections of the school to in order to maintain the highest level of functioning. Students will have resources provided to them such as mental health support from an on sight therapist. We will implemented student check-ins more frequently with teachers, and have mandatory parent teach meetings every semester. This will ensure parents, child, and teacher are on the same page about their learning efforts. We will have advisors on staff that help students determine their path for high school. This way they meet requirements but also get to have a voice in their education and learn/focus on their interests. By letting students pick certain things they will have their autonomy still and be more engaged with the learning materials."

5 – The plan is of <u>excellent quality</u>. The response addresses all the issues of the problem. The response is very clear and coherent. The response is very likely to address and fix the problem.
"To achieve academic excellence, there needs to be an understanding of what the students job is and what the teachers job is. The student is expected to try their best and to work as hard as

they can to understand the concepts they are learning. If a student fails to turn in homework they will receive a slip and get points deducted off their homework. At the end of the quarter, if the student has turned in all homework on time, they will receive a coupon that allows them to be excused from 1 homework assignment. This helps create discipline and good habits in students as they have an incentive to do well. The teacher is also expected to teach in a manner that is open to every student. The method of teaching will be "Classical Learning" as I believe it is important to have an understanding of the arts, literature, and languages before us. Students will be taught things like logic and how to debate, beginning Latin, but are also encouraged to pursue sports and theater. The school will handle things like bullying, harassment, or assault very seriously and the "attacker" will have consequences based on the attempt. There will also be special classes for people with special needs so that they can receive a good education as well. There will be buddy programs that gives students a chance to have an initiative to help others and grow in leadership. Before every year there will be a 9-12th trip to a camp and there will be things like leadership building and activities that help students feel more united as a student body. So, what all does classical learning entail, there will be a 20:1 student to teacher ratio which helps the students feel seen and makes it more likely that they will ask questions when they are struggling. All teachers that are chosen will have some type of background with teaching students with special needs as they understand patience, kindness, and encouragement towards students best. Students are encouraged to join clubs, sports, theater so that they can find their own diverse group."