Creativity and Mindset

By Ryan Bond

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Thesis Supervisor: Dr. Kasia Muldner

Institute of Cognitive Science

Carleton University

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Abstract

Creativity and its relationships with mindsets (fixed vs growth beliefs in abilities) is quite a sparsely researched field. Prior research has shown a positive relationship between performance on divergent thinking tasks and creativity mindset. This research's focus is on creative mindset and performance on convergent thinking tasks. A self-report questionnaire about creative mindset and achievement goals administered, followed by various tests of creative abilities. Results did not show any significant relationship between convergent thinking task performance and creative mindset. Ultimately creative performance on convergent thinking is not related to creative mindset. Creative mindset does however have strong correlations with learning/goal orientation and positive effort beliefs. Creative mindsets are positively related to strong beliefs in effort as well as by the desire to learn, as shown by a strong, positive correlation with learning goals.

Introduction

This study focused on 3 research questions. First and foremost, we want to see if creative mindset influences creative abilities. Using several creativity assessments in a laboratory setting, we hypothesize incremental mindset does influence creative problem solving, as was previously found (O'Connor, Nemeth, & Akutsu, 2013). Changing the measurements from solely divergent thinking tasks to convergent thinking problems would give more validity to the evidence of creative ability being influenced by mindsets. The second focus of this research is measuring the relationship between creative mindset and related factors, like the goals students set for themselves, how they are perceived by others, and their beliefs in the value of effort. Previous studies have shown that growth mindsets of intelligence are related to beliefs in learning goals, performance goals and effort (Blackwell et al., 2007; Blackwell, 2000; Paunesku et al., 2015). Effort as often been strongly related growth beliefs in mindsets as people who believe effort leads to improved ability rarely hold a fixed mindset (Tempelaar, Rienties, Giesbers, & Gijselaers, 2015). Our goal is to test if these relationships hold true for a more specific domain such as creativity. The third research question we are interested in is the difference in creative mindsets on overall creative ability as well as the other related factors. Difference in creative mindset (overall growth belief score – overall fixed belief score) may provide a better view of belief towards creative ability. The difference in creative mindset will allow us to see how much more an individual believes in one mindset compared to another. This measurement was performed due to findings which indicate that the two mindsets are distinct from one another, yet not completely independent (Hass & Katz-Buonincontro, 2016; Karwowski, 2014). The higher the difference score is, the more that individual holds and incremental view of creativity compared to a fixed view. We expect the results to provide further evidence to existing studies

that people holding a strong incremental belief of creativity will perform better on the creative tasks.

Related Work

Creativity is an important aspect of human intelligence. Some of the world's most renowned scientists and inventors were also some of the most creative people. Everyday someone comes up with a new idea that may have small consequences, or an idea so big that it can change the world forever. Businesses and technological industries alike have been founded on these unique ideas that take a certain level of creativity to achieve (O'Connor et al., 2013). Creativity can have significant impacts for psychology, business, and educators, to search for new, innovative ideas to improve on their respective fields (Brown & Kuratko, 2015; Hass & Katz-Buonincontro, 2016). Important and powerful companies are always searching for creative people to add to their team. Now more than ever, businesses are seeking creativity to encourage advancement of their product and growth in a growing technological market (O'Connor et al., 2013; Runco, 2004). In elementary school classrooms creativity is often been seen separately from intelligence and not as part of the students' success. Creativity has been integrated into testing for "giftedness" in elementary school assessments, although accurate measurements for creativity have not always been consistent (Hunsaker & Callahan, 1995; Beghetto & Kaufman, 2009).

How does one define creativity? Most commonly, it is accepted that the definition of creativity requires two parts; originality and usefulness (Piffer, 2012; Runco, 2004). It is easy for a new idea to be born, the difficult part is putting that unique idea to use. Both conditions must be met for something to be considered creative since something being unique, with no effective

use, is pointless. Something useful, yet not original cannot be considered creative therefore requiring both originality and effectiveness to be essential for the definition of creativity (Runco & Jaeger, 2012).

An important factor related to creativity is one's mindset about creative ability. Beliefs and mindsets about creativity and other mental functions are based on one question; can these abilities grow or are they fixed? Most work on mindsets have been done in academic settings. Mindsets have had important findings in the field of intelligence, where they have demonstrated that beliefs of about one's own abilities can influence school grades and other aspects of intelligence (K. L. Blackwell, Trzesniewski, & Dweck, 2007; Blackwell, 2000; Dweck, 1986). An established way to study mindsets is to measure two sets of a participant's beliefs; an *incremental* mindset (often referred to as growth beliefs), and an *entity* mindset (often referred to as fixed beliefs). Incremental beliefs suggest a belief that a given mental construct has malleability and is capable of being developed through practice. Entity beliefs require people to believe a trait is fixed, or innate, with little to no chance of improvement of a given ability (Dweck, 1986; O'Connor et al., 2013; Yeager & Dweck, 2012). Mindsets do influence one's overall performance (Blackwell, 2000; Yeager & Dweck, 2012). Fixed-mindset individuals see their mistakes as a lack in ability, often disengage from their current task leading to poorer performance, for instance in academic activities. Growth-mindset individuals are able to recover better after mistakes, leading to an increase in performance abilities. This may also be due to an increased belief in positive effort effects by those who share an incremental mindset. Mindsets have important effects on cognition, and different effects on the brain during problem solving tasks (Dweck, Chiu, & Hong, 1995; Blackwell, 2000). Growth mindset individuals focus on their

mistakes and show higher brain activity after a mistake, hypothesized to be the individuals trying to learn and improve on the given task (Schroder, Moran, Donnellan, & Moser, 2014).

Further evidence towards mindsets influence on abilities can be seen by intervention studies, which aim to change and individual's beliefs of a particular cognitive construct. (Blackwell et al., 2007; Meppelder, Hodes, Kef, & Schuengel, 2014; Paunesku et al., 2015). Blackwell's (2000) prior work confirmed that students with incremental beliefs in intelligence believed in more positive beliefs about effort and outperformed those that had fixed, non-malleable views on the subject. The study also found that changing mindsets of the students to become more malleable increased their belief of intelligence to become more positive, resulting in higher math scores (Blackwell et al., 2007). Fixed vs. malleable mindsets have often been tested for their influence on intelligence in school children, particularly to improve grades. Influencing student's mindsets to become more malleable has repeatedly demonstrated these improvements. Mindset intervention is an accurate way to determine the relationship with belief and ability. Once a relationship between mindset and cognitive ability has been established, intervention methods should be used to determine the effect and strength of the relationship (Good, Aronson, & Inzlicht, 2003).

Keeping these studies in mind, we were interested in studying the mindset phenomenon in the context of creativity, and their impact on creative outcomes. Before we describe related work, we describe the different ways of measuring creativity. Creativity is often measured in two ways. Divergent thinking tasks and convergent thinking task are two distinct types of tasks, which have both been related to different aspects of creativity (Beaty, Nusbaum, & Silvia, 2014; O'Connor et al., 2013; Piffer, 2012).

In general, in both mindset-related and other creativity studies, creativity is commonly assessed using two types of tasks: Divergent and convergent. The goal of divergent thinking tasks is to encourage originality and new ideas, as many as possible given a specific amount of time. Divergent thinking helps begin the creative process of idea generation while filtering for uniqueness and originality, but it does not ensure usefulness of the ideas (Piffer, 2012). Usefulness can be described as the ability for that idea to be operational in a real-world setting. Just because an idea is unique and creative does not ensure that it is, in fact, functional (Piffer, 2012). In contrast, convergent thinking is the ability to take in all of the given information and form a solution (O'Connor et al., 2013). Convergent thinking problems often only have one answer, but the answer can be very difficult to come across as it requires unconscious thought (Beaty et al., 2014).

One commonly used convergent thinking task for creative measurement is the Remote Associates Test (RAT) which was developed by Mednick in 1962. These tasks require solvers to find a word that is a link between three given words. For example; Fish/Mine/Rush, the answer would be Gold (Goldfish, gold mine, gold rush). RAT problems are generally seen as less complex than insight tasks, while still providing an accurate test of convergent thinking ability (Bowden & Jung-Beeman, 2003). They were developed with the purpose of measuring creative thought without requiring domain specific knowledge (Mednick, 1962). RAT problems have 3 distinct properties: (1) They misdirect the retrieval process. (2) Problem solvers have a tough time reporting the process in which they arrived at the answer. (3) It has the "Aha!" moment upon solving. It was therefore concluded that RAT problems involve similar components as complex insight problems for studying creativity (Bowden & Jung-Beeman, 2003). All solutions to RAT problems offer only one answer and therefore allow for easy scoring as well as shorter

response times, more questions to be answered in a short amount of time and more data to be collected.

Another common method of assessing creativity is by the use of insight problems, which like the RAT are a convergent task (only one answer applies). Solving insight problems requires the solver to reject initial assumptions about the problem and see the problem in new ways (Cunningham, MacGregor, Gibb, & Haar, 2009). Like the RAT problems, solutions spontaneously occur to the solver, and therefore the solution is processed unconsciously. Creative ability has long been thought to be an unconscious cognitive ability which gives rise to the solutions of these problems (Beaty et al., 2014).

There are very few studies examining creativity and mindsets, especially when it comes to the impact they have on creative performance. A notable exception is a study done in 2014, Karwowski examined Polish participants' beliefs about creativity (Karwowski, 2014). Creativity mindsets were examined to determine if people believed that creativity was malleable (could grow improve with practice), or if it was fixed (innate ability). The study created a standard questionnaire with a 5 point Likert scale used to self-report beliefs about ability and creativity. The goal of the study was to dive deeper into the relatively sparse field of both creativity and mindsets as well as develop a questionnaire to determine a person's mindset towards creativity. They also wanted to examine if beliefs of creativity fell on a continuous scale or if both a fixed and incremental belief about creativity could be held at once. The hypothesis is that creativity mindsets are not continuums of a single scale, but rather that separate mindsets that can be held simultaneously. Based on the weak correlation that was found between the two mindsets, Karwowski (2014) concluded that entity and incremental mindsets are separate constructs. The scale became a 10-item questionnaire used to measure creative mindsets, which is the scale that

is used in our current study. In a follow up study, study 2, of Karwowski (2014), she researched creative mindsets and insight problems, finding that fixed beliefs weakly correlated with scores on insight problems. The researcher proposed that further examination was needed to study the relationship between creative beliefs and ability. A more recent study on creativity and mindset also vouch the use of Karwowski's measurement scale for mindset as a more reliable test for creative mindsets, compared to previously used measures. The reason for this test was to measure the reliability of Karwowski's scale of creativity mindset compared to previous mindset questionnaires, and comparing correlations between the growth and fixed mindsets. They found Karwowski's questionnaire to be the most reliable due to consistency from the participants' answers. They also found that the correlation between growth and fixed mindsets was moderate, concluding that they should be considered as distinct constructs, but that there is still a tendency to hold one mindset over another and they should not be placed on a continuum (Hass & Katz-Buonincontro, 2016; Dweck, 1999).

A second study investigating creativity and mindset found that mindset weakly influences creative ability, using the Unusual Uses, a divergent thinking task, as a measurement for creativity (O'Connor et al., 2013). The Unusual Uses task asks participants to think of new and unique ways for a given item to be used. This study also found that participants who held a high incremental belief towards creativity also rated themselves as more creative. O'Connor et al. (2013) found there to be significant differences for participants holding different beliefs about creativity. Divergent thinking is often used to measure creativity, but creativity cannot be confined strictly to divergent thinkers.

Although mindsets of intelligence have been studied quite often, more specific domains such as creativity have been neglected. In addition to mindset, another factor that has potential to

influence creative outcomes is achievement goals. Three types of achievement goals that we are

interested in examining are learning goals, performance goals, and effort goals. Learning goals

are the desire to learn and improve their abilities, regardless of the how well one actually

performs on a task (Blackwell, 2000; Thompson & Musket, 2005). An example of a statement

that corresponds to the learning goals belief scale would be: '*I like school work that I'll learn

from even if I make a lot of mistakes'* (Blackwell, 2000). In general, people who are driven by

learning goals tend to perform better on a variety tasks than those who don't hold the same view

(Cianci, Schaubroeck, & McGill, 2010; Grant & Dweck, 2003). High learning oriented

individuals are more persistent than others, but this persistence has yet to be linked with

improved abilities (Elliot & Dweck 1988). Having a strong learning goal oriented mindset would

likely be correlated to an incremental creative mindset since the belief would be that you enjoy

learning, and therefore cognitive aspects must be able to grow (Bittner & Heidemeier, 2013; L.

S. Blackwell, 2000; Dweck, 1986; Grant & Dweck, 2003).

Performance goals may also be linked to creativity since, unlike general intelligence,

creative ideas can often be to try and impress others. Having a performance positive/approach

mindset means that it is important to you that your performance impresses others (Thompson &

Musket, 2005). In contrast, performance negative/avoid mindsets infer that you do not want to

embarrass yourself with your performance in front of others (i.e. you don't want to appear

dumb). Individuals who compare their accomplishments with others have been shown to avoid

challenge more often. This is likely due to the high risk of failure that comes with challenge

(Thompson & Musket, 2005).

The last set of achievement goals examined are effort beliefs. Effort positive are beliefs

where hard work pays off. The harder one works, the better they will perform. Effort negative

beliefs mean effort isn't all that important and most abilities are innate (Tempelaar et al., 2015; Thompson & Musket, 2005). Positive and negative effort beliefs are not independent of each other, and therefore are able to be placed on a continuum (Blackwell et al., 2007; Blackwell, 2000; Tempelaar, Rienties, Giesbers, & Gijselaers, 2015). Negative effort scores are reverse coded to create one overall score for effort, with the higher scores indicating a positive belief of effort while low scores indicate a negative belief. Creative mindsets should have a strong, positive correlation with effort beliefs (Blackwell, 2000)

Method

Participants

50 Carleton University students participated in the study (33 female students). They were recruited using SONA and were compensated for their participation with bonus grades for a first-year course in cognitive science.

Materials

The materials corresponded to (1) a series of established questionnaires used to measure beliefs in creative ability, as well as related factors (each question was answered using a Likert scale, *1=strongly disagree to 5= strongly agree*), and (2) standard creativity convergent instruments to measure creative outcomes.

Table 1.1

Questionnaire Examples

Question Type	Example Question
Growth Creativity Belief	Anyone can develop his or her creative abilities up to a certain level
Fixed Creativity Belief	You have to be born a creator – without innate talent you can only be a scribbler
Learning Orientation Belief	An important reason why I do my school work is because I like to learn new things
Performance Approach	I like school work best when I can do it perfectly without any mistakes
Performance Avoid	An important reason I do my schoolwork is so I won't embarrass myself
Effort Positive	The harder you work at something, the better you will be at it
Effort Negative	It doesn't matter how hard you work -if you're not smart, you won't do well

Note: examples of each type of question asked during the belief questionnaire

Questionnaire

The mindset questionnaire was created by Karwowski (2014), and used in previous studies to test creativity mindsets. All other questions to measure the achievement goals (Learning orientation, performance ability, effort) were taken from mindset studies created by Blackwell (2000), and can be seen in Table 1.1. Scoring methods for each questionnaire were kept the same as were done in their respective studies (L. S. Blackwell, 2000; Karwowski, 2014).
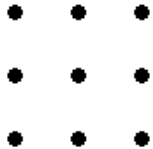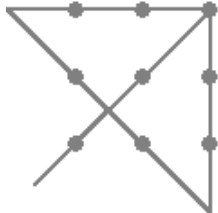
Creativity tasks

We used RAT problems and insight problems as the measures of creativity. All RAT problems had only one correct answer. RAT problems were taken from a study determining difficulty of RAT problem, and were selected based on difficulty to control for a floor or ceiling

effect (Bowden & Jung-Beeman, 2003). The order of the RAT problems was then randomized for the experiment, see Table 1.2.

All insight problems were taken from a previous study using insight problems to test for various forms of creativity (Dow, & Mayer, 2004). Insight problems were selected by using a variety of insight tasks related to math, spatial awareness, and word puzzles. Insight problems require the solver to use all of the given information to generate an answer to the given problem, often requiring outside-the-box thinking to solve. The two types of tasks were evaluated via a pilot study on six individuals to test difficulty of the problems and confirm there would be no floor or ceiling effect in the data as well as ensure that there would be variance in the scores, which the pilot data confirmed. The pilot data was not included in the final analysis.

Table 1.2

Creativity Measures

Type of puzzle	Example
Insight Questions	**The 9 Dots:** Draw four continuous straight lines, connecting all the dots without lifting your pencil from the paper. Solution:
Remote-Association Questions	wise/work/tower **Solution:** Clock

Note: examples of the two types of problems used in the study, along with their solutions.

Procedure

The study was conducted in a classroom, with each session involving 1-6 participants. Each session took at most 1 hour. To minimize disruption, the desks in the classroom were placed facing the outside of the room. All participants were instructed to begin and end at the same time to avoid confusion.

After signing a consent form, participants filled in the questionnaires described above to measure the beliefs in creative abilities and related factors. Once they did, the next phase

involved the two creativity tasks, starting with the insight problems. Participants were given 20 minutes to complete the eight insight problems – they were given all problems as one set and so could choose the order they completed them. Participants were asked to use the full allotted time to complete the problems, and if they finished early, they were asked to read over their solutions until the 20 minutes had ended. When the time was up, participants were instructed to drop their writing utensil while the experimenter collected the sheets. Participants were then asked to complete the 23 Remote Associate Task (RAT problems) and were given 15 minutes to answer as many of the items as they could in any order they wished. Participants were instructed to read over the problems again if they were finished early. Finally, participants were thanked and offered a debrief form to inform them of the purpose of the study

Results

Table 1.3

Descriptives of results

Analysis	Mean	Standard Deviation
Insight Score	1.34	1.12
RAT score	12.30	3.67
Growth Creativity Belief	4.06	0.47
Fixed Creativity Belief	2.60	0.58
Difference (growth-fixed)	1.46	0.78
Learning Orientation	3.49	0.73
Performance Approach	3.85	0.61
Performance Avoid	2.41	1.04
Effort	3.89	0.41

Growth mindset and Fixed mindset were held as separate entities due to previous research that indicated that both mindsets could be held simultaneously and that creative mindset is not a unipolar construct (Karwowski, 2014). The goal orientation questions were also kept as three constructs (learning, performance avoid, performance approach), again following prior research (L. S. Blackwell, 2000). Effort and Performance mindsets were coded according to previous research using these questionnaires to investigate mindsets (L. S. Blackwell, 2000). Specifically, negative effort questions were reverse coded, then paired and averaged along with positive effort questions in to evaluate a total mindset for effort.

The descriptives for the data are shown in Table 1.3. The results in our study differ form those found in Karwowski's (2014) study using the same measurements, where we found a greater mean score for Growth mindset, and a smaller mean score for Fixed mindset, along with smaller standard deviations for both mindsets, thus providing greater difference between the strength of mindsets help by our participants.

We now present our results, organized according to our research questions. The primary analysis corresponded to correlational analysis, using a two-tail test at alpha level = .05.

RQ1: Relationship between creativity mindset and creative performance

As far as growth mindset scores, there was no significant correlation between growth Mindset of creativity and Insight scores ($r = 0.03$, $p = 0.835$), and the effect size was very small. There was also no significant correlation between RAT scores and growth mindset of creativity ($r = -0.131$, $p = 0.365$), and again the effect size was small.
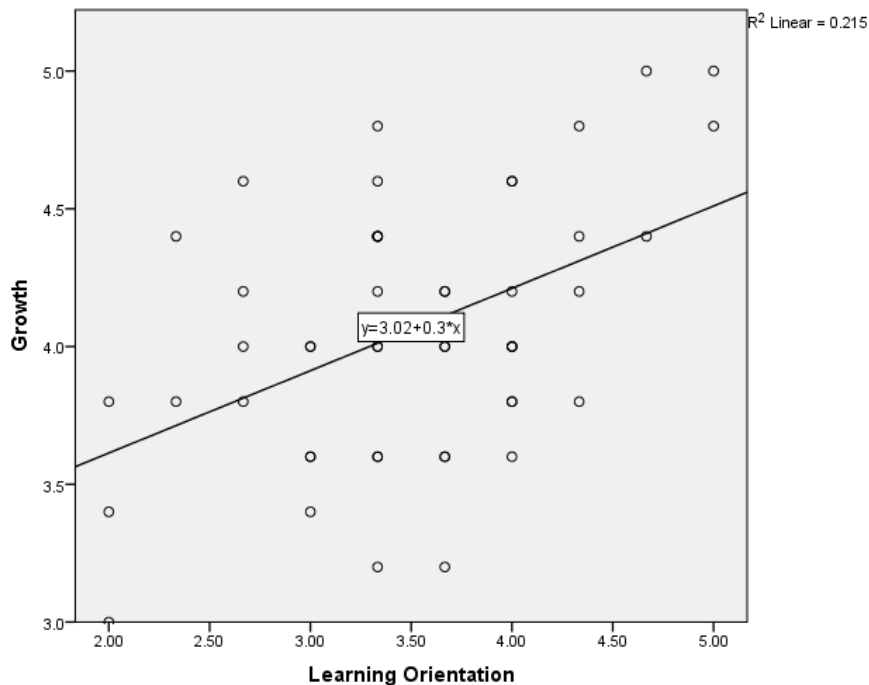
The same pattern of results held for the entity mindset scores: Fixed mindset was not significantly correlated with either Insight scores ($r = 0.044$, $p = 0.762$) or RAT score ($r = -0.075$, $p = 0.607$), and the effect sizes were very small.

RQ2: Relationship between creativity mindset and related factors

Having a strong learning orientation refers to the participant enjoying learning for their own benefit rather than for the sole purpose of achieving high grades. We found a strong positive correlation between learning goals and incremental mindset ($r = 0.464$, $p = 0.001$), as shown in Figure 1.1. Mirroring this finding, there was a negative, medium-large correlation between Learning goals and fixed mindset ($r = -0.355$, $p = 0.011$), displayed in Figure 1.2.
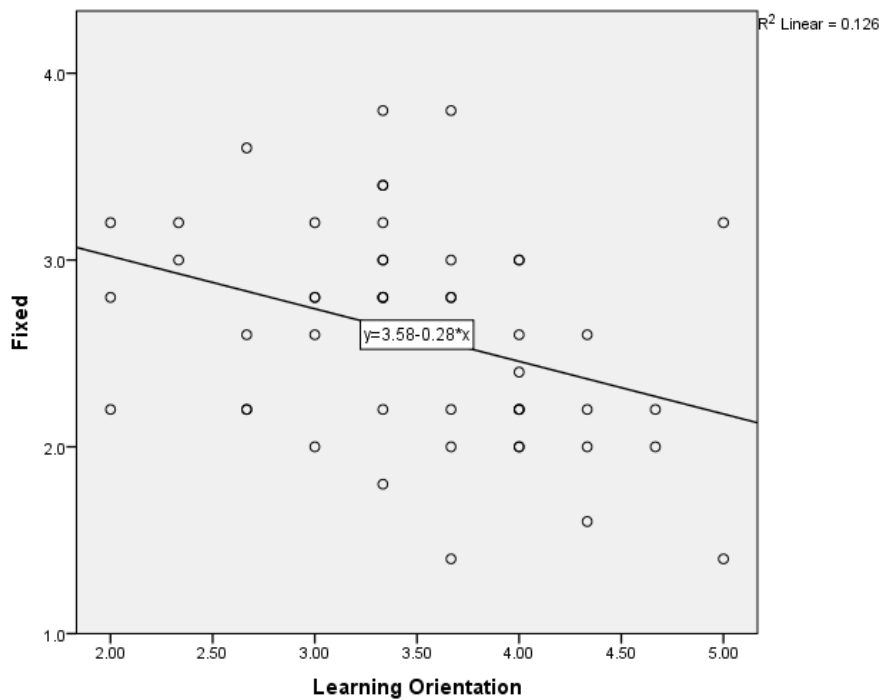
Figure 1.1

Growth Belief Score vs. Learning Orientation Score

Note: scatterplot data of Growth Mindset vs. learning orientation ($r = 0.464$).
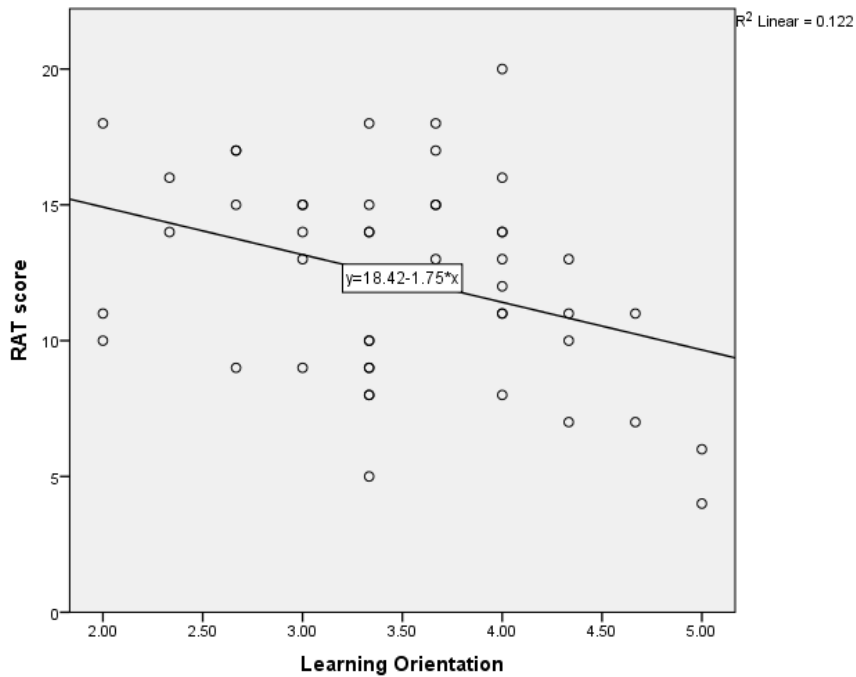
Figure 1.2

Fixed Mindset Score vs. Learning Orientation Score

Note: displays the scatterplot data of Fixed Mindset vs. Learning orientation ($r = -0.355$)

Insight problems had no other significant correlations with any other beliefs. In contrast, RAT score did have a significant, medium strength, negative correlation with Learning Orientation ($r = -0.350$, $p = 0.013$), displayed in Figure 1.3.

Figure 1.3

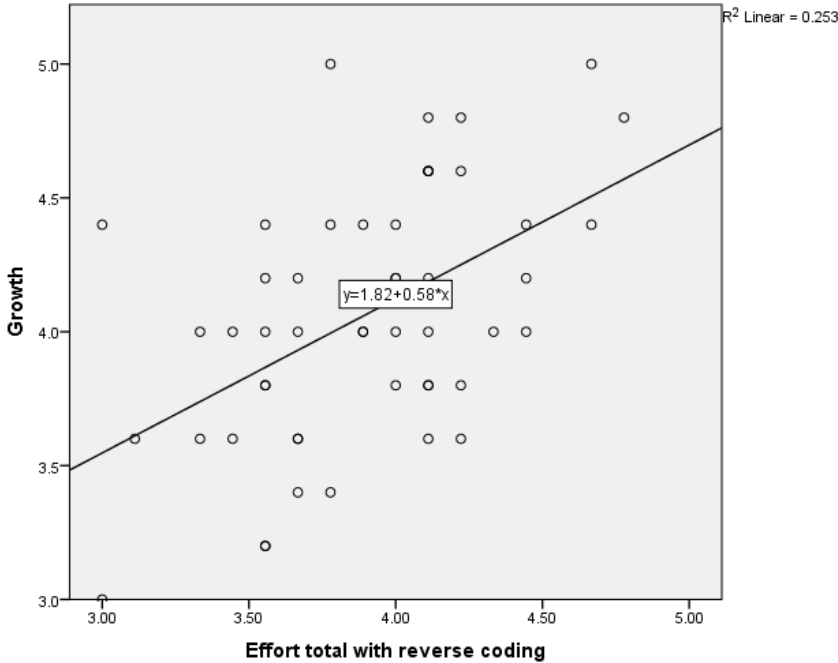*RAT Score vs. Learning Orientation Score*

Note: displays the correlation between RAT score and Learning Orientation belief (r = -0.350)

We next analyzed effort beliefs - higher score indicating the belief that the harder one works at something the better they will do. There was a strong, positive correlation (r = 0.503, p < 0.001) between effort beliefs and incremental mindset, as shown in Figure 1.4. Mirroring these findings, we found a, negative strong relationship between fixed creative mindset and effort (r = -0.460, p = 0.001), as shown in Figure 1.5.
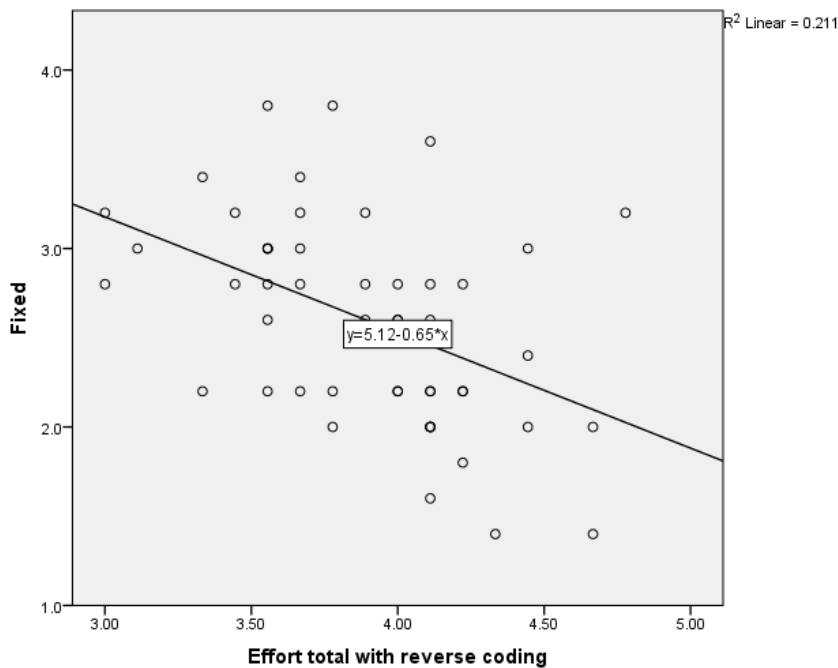
Performance Approach and Performance Avoid Performance Avoid were not found to have any significant relationships with creativity mindsets or creativity tasks.

Figure 1.4

Growth Mindset Score vs. Effort Score

R^2 Linear = 0.253

y=1.82+0.58*x

Growth

Effort total with reverse coding

Note: correlation between Growth mindset and Effort beliefs ($r = 0.503$)

Figure 1.5

Fixed Mindset Score vs. Effort Score

Note: correlation between fixed mindset belief and effort belief ($r = -0.460$)
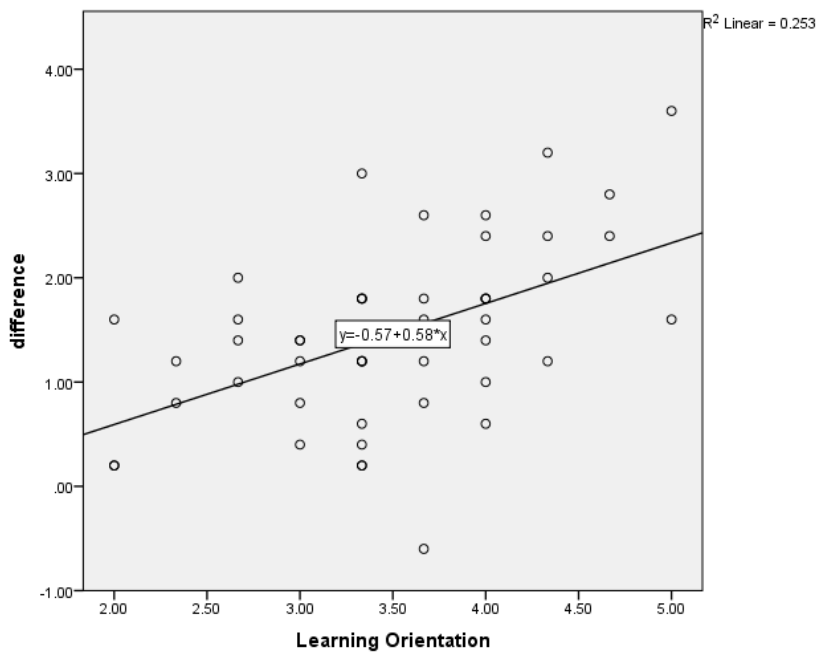
RQ3: Relationship between Difference in creative beliefs vs Learning orientation and Effort

We were interested in determining if the strength of one creative mindset (e.g., entity) compared to the other (e.g., incremental) had an impact in other beliefs. To address our third research question, we analyzed mean difference in growth vs fixed mindset (Difference = Growth mindset – Fixed mindset). Difference was analyzed to find the score of one mindset was held compared to the other. When the difference was analyzed, significant, strong, positive correlations were found for both Learning Orientation ($r = 0.503$, $p < 0.001$) and Effort scores (r

= 0.596, $p < 0.001$). These are visible in Figure 1.6 and Figure 1.7, respectively. This score was used to analyze participants' overall belief in a growth mindset, compared to a fixed mindset about malleability of creativity.
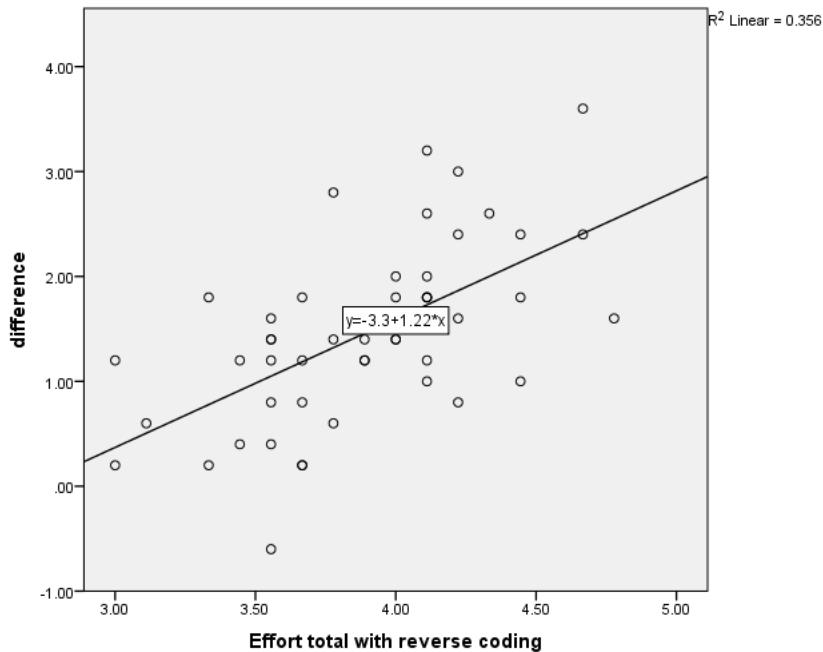
Figure 1.6

Difference in Creative Mindset Score vs. Learning Orientation Score

Note: correlation between Difference in creative mindset vs Learning Orientation ($r = 0.503$)

Figure 1.7

Difference in Creative Mindset Score vs. Effort Score

Note: correlation between Difference in creative mindset vs Effort ($r = 0.596$)

Discussion

This study suggests that convergent thinking tasks measuring creativity have no

relationship with creative mindsets. Although previous work has found there to be a significant

relationship with creative ability and type of creative mindset, this study found that this

relationship is not a significant relationship, nor is it strong (O'Connor et al., 2013). Different

tasks were used in our study, measuring a different kind of thinking. Using convergent testing

methods, we found no relationship. This has three possible alternate explanations. One is that

convergent thinking tasks do not relate to creativity mindset. Whether someone has a malleable

view or a fixed view of their own creative abilities, those beliefs do not impact their creative ability when performing convergent thinking tasks, such as the RAT and insight problems. Another explanation to consider is that there is a disconnect between type of creativity assessed in the task and the creativity assessed by the mindset questionnaire. Perhaps when participants are answering the mindset questionnaire they are thinking of creativity in a very traditional sense. We speculate that participants were thinking of art, music, writing and other domains that are often seen as requiring creativity, rather than puzzles. This could explain the disconnect between mindset questionnaire and tasks, and be a possible reason for the lack of relationship between the two. One final explanation is the possibility that only divergent tasks are affected by mindsets. The results showed a very small effect size for both RAT and insight problems relationships with growth and fixed creativity mindset. The fact that all results between mindset and creativity scores show consistent low strength provides some, be it minor, evidence towards the very small link between mindset and convergent thinking achievements. This result is surprising given previously discussed results with studies involving mindsets influence on creative ability, where incremental believes had a positive, moderate relationship with divergent thinking tasks (O'Connor et al., 2013). Convergent thinking tasks will need more research done to find the full effect of their relationship with mindsets.

Other measures related to mindset were also not significantly associated with mindset. Performance approach and performance avoid questionnaires yielded no significant results when compared with creativity mindsets. This indicates that the feeling of avoiding embarrassment as well as the desire to impress others, constructs measured by these questionnaires, were not significantly associated with beliefs about creativity. In contrast, the relationship between learning orientation and creative mindset was significant for both growth and fixed mindset. This

finding is evidence for people with strong beliefs in malleability of abilities enjoy learning new things. The findings were similar when beliefs between ability in an academic setting and learning goal orientations were performed (Blackwell, 2000; Cianci et al., 2010). Logically, this makes sense as individuals who hold strong beliefs that an ability can grow probably enjoy learning more, as they will see it as a benefit to them in the future.

The medium-strong negative correlation between fixed mindset and learning orientation provides further evidence for this theory, as fixed belief individuals would be more inclined to believe in innate abilities and viewing creativity as a more difficult task. Blackwell (2000) found that students who believed more strongly in favour of learning goals were more motivated to perform better on tasks. These more motivated individuals would also perform better on mathematics tasks. It is interesting we did not see this in our study, and perhaps it is again related to the convergent problems that were asked. The most surprising finding was the correlation between RAT score and learning orientation. Not only was the finding significant, but it was a medium strength negative correlation. This was unexpected since studies had found that learning orientation is related to increased performance (Blackwell, 2000; Grant & Dweck, 2003). One reason for this result may be due to the nature of the test. Since high learning orientation is related to the desire to learn and not the desire for high grades, it is possible that individuals with higher learning orientation scores saw the test as a grading system without learning purposes. If these individuals felt that there was nothing to learn from the task, that may have diminished their motivation to succeed and ultimately affected their results.

Effort beliefs were strongly correlated positively with growth mindset and negatively with fixed mindset. People who believe in growth of a certain mindset would certainly have the belief that putting in effort would improve your abilities at a given task, in this case creativity.

The same logic holds for negative correlation between effort and fixed mindset of creativity. Effort did not have any relationships with creative tasks. Individuals may believe in the ability of effort to improve results, however this does not play out in practice as seen by lack of relationship. One could also argue that those that have strong beliefs in effort to improve performance may have tried harder, but did not succeed any better than those with a weaker belief about effort. It is difficult to distinguish if this is true given our data, as we did not test for the amount of effort used towards the tasks.

Creative mindsets have been found to be independent of one another, and for that reason they are not placed on a continuum when scored (Hass & Katz-Buonincontro, 2016; Karwowski, 2014; O'Connor et al., 2013). We examined the difference in participants' beliefs when growth was compared with fixed mindsets. High scores would indicate a stronger belief in growth mindset over fixed mindset. We found that this difference score provided similar results to previous findings in our research. Higher difference was positively, and strongly correlated with both learning orientation and effort.

Future work should examine a comparison between convergent and divergent thinking tasks when testing the relationship between creativity and creative mindsets. Directly comparing convergent and divergent thinking task will make it possible to determine what their relationships are with mindset. Future research could also examine a potential method to more accurately measure creative mindset in respect to convergent tasks. If the creative mindset questionnaire used in this study is not reflective of convergent thinking abilities, then perhaps there is a more accurate way to measure these beliefs.

In conclusion, we did not find evidence of a relationship between creative mindset and creative performance when convergent thinking tasks are the target measure. Creative mindset was strongly linked with related factors, such as learning orientation and effort, but not with beliefs about performance. Future work should investigate the relationship between other convergent and divergent thinking tasks with creative mindsets.

References

Beaty, R. E., Nusbaum, E. C., & Silvia, P. J. (2014). Does Insight Problem Solving Predict Real-

World Creativity? *Psychology of Aesthetics, Creativity, and the Arts*, *8*(3), 287–292.

http://doi.org/10.1037/a0035727

Bittner, J. V., & Heidemeier, H. (2013). Competitive mindsets, creativity, and the role of

regulatory focus. *Thinking Skills and Creativity*, *9*, 59–68.

http://doi.org/10.1016/j.tsc.2013.03.003

Blackwell, K. L., Trzesniewski, K. H., & Dweck, C. S. (2007). Implicit Theories of Intelligence

Predict Achievement Across an AdolescentTransition: A Longitudinal Study and an

Intervention in Child. *Child Development*, *78*(1), 246–263. http://doi.org/10.1111/j.1467-

8624.2007.00995.x

Blackwell, L. S. (2000). Psychological Mediators of Student Achievement During the Transition

to Junior High School: The Role of Implicit Theories. *Arbor Ciencia Pensamiento Y*

Cultura. http://doi.org/10.16953/deusbed.74839

Bowden, E. M., & Jung-Beeman, M. (2003). Normative data for 144 compound remote associate

problems. *Behavior ResearchMethods, Instruments,& Computers*, *35*(4), 634–639.

http://doi.org/10.3758/BF03195543

Brown, T. J., & Kuratko, D. F. (2015). The Impact of Design and Innovation on the Future of

Education. *Psychology of Aesthetics, Creativity, and the Arts*, *9*(2), 147–151.

http://doi.org/10.1037/aca0000010

Cianci, A. M., Schaubroeck, J. M., & McGill, G. A. (2010). Achievement Goals, Feedback, and

Task Performance. *Human Performance*, *23*(2), 131–154.

http://doi.org/10.1080/08959281003621687

Cunningham, J. B., MacGregor, J. N., Gibb, J., & Haar, J. (2009). Categories of insight and their

correlates: An exploration of relationships among classic-type insight problems, rebus

puzzles, remote associates and esoteric analogies. *The Journal of Creative Behavior*, *43*(4),

262–280. http://doi.org/10.1002/j.2162-6057.2009.tb01318.x

Dow, G.T. & Mayer, R.E. (2004). Teaching students to solve insight problems. Evidence for

domain specificity in training. *Creativity Research Journal, 16,4* 389-402

Dweck, C. S. (1986). Motivational processes affecting learning. *American Psychologist*, *41*(10),

1040–1048. http://doi.org/10.1037/0003-066X.41.10.1040

Dweck, C. S. (2006). Mindset: The new psychology of success. New York, NY: Random House.

Good, C., Aronson, J., & Inzlicht, M. (2003). Improving adolescents' standardized test

performance: An intervention to reduce the effects of stereotype threat. *Journal of Applied

Developmental Psychology*, *24*(6), 645–662. http://doi.org/10.1016/j.appdev.2003.09.002

Grant, H., & Dweck, C. S. (2003). Clarifying Achievement Goals and Their Impact. *Journal of

Personality and Social Psychology*, *95*(3), 541–553. http://doi.org/10.1037/0022-

3514.85.3.541

Hass, R. W., & Katz-Buonincontro, J. (2016). Disentangling creative mindsets from creative

self-efficacy and creative identity: Do people hold fixed and growth theories of creativity?

Psychology of Aesthetics, Creativity, and the Arts, *10*(4), 436–446.

Hunsaker, S. L., & Callahan, C. M. (1995). Creativity and giftedness: Published instrument uses and abuses. *Gifted Child Quarterly*, *39*, 110–114. http://doi.org/10.1177/001698629503900207

Karwowski, M. (2014). Creative mindsets: Measurement, correlates, consequences. *Psychology of Aesthetics, Creativity, and the Arts*, *8*(1), 62–70. http://doi.org/10.1037/a0034898

Beghetto, R., & Kaufman, J. (2009). Connecting Learning and Creativity in Programs of Advanced Academics. *Intellectual Estuaries:, 20*(2), 296–324.

Mednick, S. A. (1962). The associative basis of the creative process. *Psychological Review, 69,* 220-232.

Meppelder, M., Hodes, M. W., Kef, S., & Schuengel, C. (2014). Expecting change: Mindset of staff supporting parents with mild intellectual disabilities. *Research in Developmental Disabilities*, *35*(12), 3260–3268. http://doi.org/10.1016/j.ridd.2014.08.015

O'Connor, A. J., Nemeth, C. J., & Akutsu, S. (2013). Consequences of Beliefs about the Malleability of Creativity. *Creative Research Journal*, *25*(2), 155–162. http://doi.org/10.1080/10400419.2013.783739

Paunesku, D., Walton, G. M., Romero, C., Smith, E. N., Yeager, D. S., & Dweck, C. S. (2015). Mind-Set Interventions Are a Scalable Treatment for Academic Underachievement. *Psychological Science*, *26*(6), 784–793. http://doi.org/10.1177/0956797615571017

Piffer, D. (2012). Can creativity be measured? An attempt to clarify the notion of creativity and general directions for future research. *Thinking Skills and Creativity*, *7*(3), 258–264. http://doi.org/10.1016/j.tsc.2012.04.009

Runco, M. a. (2004). Creativity. *Annual Review of Psychology*, *55*(1), 657–687.

http://doi.org/10.1146/annurev.psych.55.090902.141502

Runco, M. a., & Jaeger, G. J. (2012). The Standard Definition of Creativity. *Creativity Research*

Journal, *24*(1), 92–96. http://doi.org/10.1080/10400419.2012.650092

Schroder, H. S., Moran, T. P., Donnellan, M. B., & Moser, J. S. (2014). Mindset induction

effects on cognitive control: A neurobehavioral investigation. *Biological Psychology*,

103(1), 27–37. http://doi.org/10.1016/j.biopsycho.2014.08.004

Tempelaar, D. T., Rienties, B., Giesbers, B., & Gijselaers, W. H. (2015). The Pivotal Role of

Effort Beliefs in Mediating Implicit Theories of Intelligence and Achievement Goals and

Academic Motivations. *Social Psychology of Education*, *18*(1), 101–120.

http://doi.org/10.1007/s11218-014-9281-7

Thompson, T., & Musket, S. (2005). Does priming for mastery goals improve the performance of

students with an entity view of ability? *The British Journal of Educational Psychology*,

75(3), 391–409. http://doi.org/10.1348/000709904X22700

Yeager, D. S., & Dweck, C. S. (2012). Mindsets that promote resilience: When students believe

that personal characteristics can be developed. *Educational Psychologist*, *47*(4), 302–314.

http://doi.org/10.1080/00461520.2012.722805

Appendix A

Measures used during test

Demographic Questionnaire

What is your major at Carleton? _____

What is your year of study? _____

What is your gender? _____

What the language you feel most comfortable speaking? _____

Belief questionnaire

Everyone can create something great at some point if he or she is given appropriate conditions

Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
1	2	3	4	5

You either are creative or you are not – even trying very hard you cannot change much

Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
1	2	3	4	5

Anyone can develop his or her creative abilities up to a certain level

Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
1	2	3	4	5

You have to be born a creator – without innate talent you can only be a scribbler

Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
1	2	3	4	5

Practice makes perfect – perseverance and trying hard are the best ways to develop and expand one's capabilities

Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
1	2	3	4	5

Creativity can be developed, but one either is or isn't not a truly creative person

Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
1	2	3	4	5

Rome wasn't built in a day – each creativity requires effort and work, and these two are more important than talent

Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
1	2	3	4	5

Some people are creative, others aren't – and no practice can change it

Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
1	2	3	4	5

It doesn't matter what creativity level one reveals – you can always increase it

Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
1	2	3	4	5

A truly creative talent is innate and constant throughout one's entire life

Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
1	2	3	4	5

An important reason why I do my school work is because I like to learn new things

Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
1	2	3	4	5

I like school work best when it makes me think hard

Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
1	2	3	4	5

I like school work that I'll learn from even if I make a lot of mistakes

Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
1	2	3	4	5

I like school work best when I can do it perfectly without any mistakes

Strongly Disagree   Disagree   Neutral   Agree   Strongly Agree
1   2   3   4   5

The main thing I want when I do my school work is to show how good I am at it

Strongly Disagree   Disagree   Neutral   Agree   Strongly Agree
1   2   3   4   5

I like school work best when I can do it really well without too much trouble

Strongly Disagree   Disagree   Neutral   Agree   Strongly Agree
1   2   3   4   5

An important reason I do my schoolwork is so I won't embarrass myself

Strongly Disagree   Disagree   Neutral   Agree   Strongly Agree
1   2   3   4   5

An important reason I work hard in school is so others won't think I'm not smart

Strongly Disagree   Disagree   Neutral   Agree   Strongly Agree
1   2   3   4   5

The harder you work at something, the better you will be at it

Strongly Disagree   Disagree   Neutral   Agree   Strongly Agree
1   2   3   4   5

When something is hard, it just makes me want to work more on it, not less

Strongly Disagree   Disagree   Neutral   Agree   Strongly Agree
1   2   3   4   5

If you don't work hard and put in a lot of effort, you probably won't do well

Strongly Disagree   Disagree   Neutral   Agree   Strongly Agree
1   2   3   4   5

If an assignment is hard, it means I'll probably learn a lot doing it

Strongly Disagree   Disagree   Neutral   Agree   Strongly Agree
1   2   3   4   5

When I work hard at my schoolwork, it makes me feel like I'm not very smart

Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
1	2	3	4	5

It doesn't matter how hard you work -if you're not smart, you won't do well

Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
1	2	3	4	5

If you 're not good at a subject, working hard won't make you good at it

Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
1	2	3	4	5

If a subject is hard for me, it means I probably won't be able to do really well at it

Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
1	2	3	4	5

If you're not doing well at something, it's better to try something easier

Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
1	2	3	4	5

I think I can enjoy puzzles that make me think

Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
1	2	3	4	5

Puzzles that make me think are boring

Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
1	2	3	4	5

I think being good at puzzles that require creativity is just a matter of some practice

Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
1	2	3	4	5

I think being creative is just not for me

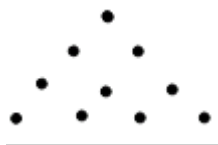| Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
1	2	3	4	5

I like puzzles that are easy to solve, even if I do not learn from doing them

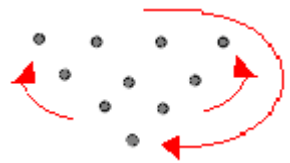| Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
1	2	3	4	5

Insight Problems

Please solve as many puzzles as possible. You may solve them in any order you wish

1. Triangle: The triangle shown below points to the top of the page. Show how you can move three circles to get the triangle to point to the bottom of the page.

Solution:

2. Letter Z: Can you figure out where to put the letter Z, top or bottom line and Why?

        A EF HI KLMN T VWXY

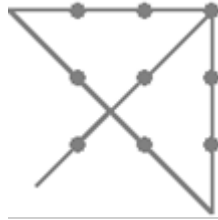   ------------------------

        BCD G J OPQRS U

Solution: Top, all letters with a curved line in them are on the bottom.

3. The 9 Dots: Draw four continuous straight lines, connecting all the dots without lifting your pencil from the paper.

Solution:

4. Strings: There are two strings hanging from the ceiling in the room below. The woman cannot reach both. How can she tie the two strings together?

Solution: Tie a paint pot to one string and swing it in motion. Grasp the other string and wait for the paint pot to swing into your reach *OR* use the pliers on the ground as an extension of the arm to grasp the string

5. Tumor: Imagine you are a doctor treating a patient with a malignant stomach tumor. You cannot operate but you must destroy the tumor. You could use high intensity X rays to destroy the tumor but unfortunately the intensity of the X rays needed to destroy the tumor also will destroy healthy tissue through which the X rays must pass. Less power full X rays will spare the healthy tissue but will not be strong enough to destroy the tumor. How can you destroy the tumor without damaging the healthy tissue?

Solution: Use multiple X rays from multiple points of origin that converge all at the same spot: the tumor

6. Pencils: How can you arrange 6 identical pencils in such as way as to form 4 identical triangles whose sides area are all equal, without modifying the pencils in any way?

Solution: Make a pyramid, three on the base and three on the sides

7. Cards: Three cards lie face down on a table, arranged in a row from left to right. We have the following information about them.

a. The Jack is to the left of the Queen

b. The Diamond is to the left of the Spade

c. The King is to the right of the Heart

d. The Spade is to the right of the King.

Which card - by face and suit - occupies each position?

Solution: Jack of hearts, King of Diamonds, Queen of Spades

8. Chain: A girl has four pieces of chain. Each piece is made up of three links. She wants to join the pieces into a single closed loop of chain (like a necklace). To open a link costs 2 cents and to close a link costs 3 cents. She only has 15 cents. How does she do it?

Solution: Open all the links from one piece and use those to attach the three remaining pieces together.

Remote Association Test

*The goal of the RAT problems is to think of a word that connects to all three of the displayed words. For example: arm/tar/peach? The answer would be **pit***

*Arm**pit,** tar **pit,** peach **pit***

*One more example, to demonstrate that the target word could appear either before or after the displayed words; boot/ground/summer? The answer: **camp***

*Boot**camp,** **camp**ground, summer **camp***

Please answer as many as you can in the allotted time (15 minutes). You can solve them in any order.

1. dew/comb/bee

honey

2. dress/dial/flower

sun

3. river/note/account

bank

4. cane/daddy/plum

sugar

5. cat/number/phone

call

6. pile/market/room

stock

7. flower/friend/scout

girl

8. carpet/alert/ink

red

9. cracker/fly/fighter

Fire

10. cream/skate/water

ice

11. cottage/swiss/cake

cheese

12. night/wrist/stop

watch

13. sleeping/bean/trash

bag

14. tank/hill/secret

top

15. flake/mobile/cone

snow

16. foul/ground/mate

play

17. tail/water/flood

gate

18. hound/pressure/shot

blood

19. fight/control/machine

gun

20. opera/hand/ dish

soap

21. stick/maker/point

match

22. Loser/throat/spot

sore

23. Home/arm/room

rest

Appendix B

Questionnaire sorted in relation to what each question tested for

Questions For Growth Mindset

Everyone can create something great at some point if he or she is given appropriate conditions

Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
1	2	3	4	5

Anyone can develop his or her creative abilities up to a certain level

Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
1	2	3	4	5

Practice makes perfect – perseverance and trying hard are the best ways to develop and expand one's capabilities

Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
1	2	3	4	5

Rome wasn't built in a day – each creativity requires effort and work, and these two are more important than talent

Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
1	2	3	4	5

It doesn't matter what creativity level one reveals – you can always increase it

Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
1	2	3	4	5

Questions for Fixed entity Mindset

You either are creative or you are not – even trying very hard you cannot change much

Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
1	2	3	4	5

You have to be born a creator – without innate talent you can only be a scribbler

Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
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Creativity can be developed, but one either is or isn't not a truly creative person

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Some people are creative, others aren't – and no practice can change it

Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
1	2	3	4	5

A truly creative talent is innate and constant throughout one's entire life

Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
1	2	3	4	5

Learning Goal Orientation

An important reason why I do my school work is because I like to learn new things

Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
1	2	3	4	5

I like school work best when it makes me think hard

Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
1	2	3	4	5

I like school work that I'll learn from even if I make a lot of mistakes

Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
1	2	3	4	5

Performance Approach

I like school work best when I can do it perfectly without any mistakes

Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
1	2	3	4	5

The main thing I want when I do my school work is to show how good I am at it

Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
1	2	3	4	5

I like school work best when I can do it really well without too much trouble

Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
1	2	3	4	5

Performance Avoid

An important reason I do my schoolwork is so I won't embarrass myself

Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
1	2	3	4	5

An important reason I work hard in school is so others won't think I'm not smart

Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
1	2	3	4	5

Effort Positive

The harder you work at something, the better you will be at it

Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
1	2	3	4	5

When something is hard, it just makes me want to work more on it, not less

Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
1	2	3	4	5

If you don't work hard and put in a lot of effort, you probably won't do well

Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
1	2	3	4	5

If an assignment is hard, it means I'll probably learn a lot doing it

Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
1	2	3	4	5

Effort negative

When I work hard at my schoolwork, it makes me feel like I'm not very smart

Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
1	2	3	4	5

It doesn't matter how hard you work -if you're not smart, you won't do well

Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
1	2	3	4	5

If you 're not good at a subject, working hard won't make you good at it

Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
1	2	3	4	5

If a subject is hard for me, it means I probably won't be able to do really well at it

Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
1	2	3	4	5

If you're not doing well at something, it's better to try something easier

Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
1	2	3	4	5

Answers omitted from study

I like puzzles that are easy to solve, even if I do not learn from doing them

Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
1	2	3	4	5

Puzzles that make me think are boring

Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
1	2	3	4	5

I think being good at puzzles that require creativity is just a matter of some practice

Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
1	2	3	4	5

I think I can enjoy puzzles that make me think

Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
1	2	3	4	5

I think being creative is just not for me

Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
1	2	3	4	5