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The Role of Diversity of Academic Major in Influencing Group and Individual Creativity

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The Role of Diversity of Academic Major in Influencing Group and Individual Creativity

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Abstract

This study examined, on a preliminary basis, the role of diversity of academic major in influencing individual and group divergent thinking. Prior studies on diversity provide evidence that working with diverse individuals can make groups more productive in generating creative ideas. Diversity of academic major is an important element of group diversity that has not been sufficiently studied. This study provided direction for future research to help us understand the ways that diversity may influence creative thinking as well as enrich the school curriculum. A total of 56 graduate students from University of Connecticut were recruited to study this issue. The Alternate Uses Test was used to obtain the divergent thinking score, which is an essential indicator of creative thinking of individuals and groups. The scores on three outcomes of divergent thinking (fluency, flexibility and originality) were collected to analyze if students in diverse academic major groups work better than those in non-diverse academic major groups. The results show that groups with divergent majors, perform more effectively on the originality score for both individual tasks and the group creativity task, compared to groups with common majors. The groups with divergent majors also appeared to have a significant higher mean fluency score during group activity compared to the groups with common major. In addition, the results demonstrate that groups with different majors and groups with common majors performed differently through different time series during group activity. Results indicated that the diversity of majors in group can make individual and group more productive in generating novel ideas.

Keywords: Creativity, Diversity, Academic Major, Divergent Thinking

The Role of Diversity of Academic Major in Influencing Group and Individual Creativity

Creativity studies have exhibited explosive growth in the past 50 years because human creativity flourishes in a world filled with opportunities, changes, information, and technology. Creativity studies have spread rapidly to diverse areas of psychological research and to many other fields of study. The value of creativity has been revealed in previous research: it is described as the most important economic resource in the 21st century (Florida, 2002). Considering that it might be linked to a nation's prosperity, nations are in competition to nurture their creative talent (Florida, 2006).

What is creativity? In the Cambridge Handbook of Creativity, a creative response is described as "novel, good, and relevant", which means that a creative idea is something different and new, high quality and relevant to the task at hand (Kaufman, & Sternberg, 2010, p. xiii). Although we always marvel at the creative products created by intelligent people, the root of creativity is not superficial. It is rooted in insight – the mind's work by ordinary individuals as well as geniuses. Many studies have shown that creative thinking is mediated by the interaction between individual and environment (Glaveanu, 2013). Everyone could actually benefit from these so-called "creative moments" in everyday life, especially when people solve problems. It is certain that learning about the environment or the group contexts in which creativity flourishes, i.e. how they maintain, weaken or foster creativity, is important to study.

To achieve the goal of creating environments in which the creative potential of people is fulfilled, the focus of creativity research has shifted from the creativity within individuals to creativity within environmental and sociocultural contexts (Glaveanu, 2013). Instead of exploring individuals' mental stages, personality traits or behaviors, the emergence of creative

ideas may be better explained in terms of group work (Sawyer, 2010). The purpose of this study was to extend prior study on a particular factor, diversity, which can influence creativity within group work.

Statement of the Problem

Diversity, according to Harvey (2013), is described as a factor that can improve creativity within group work. Although the conceptualization of diversity has not been described clearly by academics (Unzueta, Knowles, & Ho, 2012), the complexity of the definition of diversity makes it certain that it might come in many different forms. Diversity includes individual perspectives, life experiences, mindsets, gender, age, race, and many other components. The functional value of several kinds of diversity in group is a topic of debate. During the last twenty years, studies on creativity have been conducted within groups in cross-cultural contexts (Wang, 2012) and within groups of people that have divergent thinking (Harvey, 2013; Milliken, Bartel, & Kurtzberg, 2003). They have also been conducted on groups of people that have different life experiences, gender, ethnicity, and nationalities (Pluut, & Curşeu, 2013; McLeod, Lobel, & Cox, 1996; O'Reilly, Williams, & Barsade, 1998). Diversity has become a focus that is frequently studied when psychologists think about creativity in groups, however, the consequences of different aspects of diversity on group creativity are not clear in the current literature.

Creativity is an essential source for graduate students, as graduate study and research require new and distinctive thinking. Studying a specific major for years in college is a common way for students to determine their own interest of study, knowledge background, and specific major skills that differ from those of other people. Graduate students have strong academic backgrounds in their field of study and often work in groups to do a project or research. They

often have less opportunity to work with people who have other academic major backgrounds. However, a question arises: Is it beneficial for researchers to always work with people who have spent years studying in the same field of study?

There is a research project funded by Imperial College London called "Encouraging Creativity in PhD and Postdoc Researchers," which aims to help graduates acquire more unexpected and exciting research findings and foster their ability to generate new ideas, processes, products and divergent thinking with other students of different majors (Anders, & Walsh, 2015). Diversity can make work groups more "productive" (Page, 2007). Too much homogeneity in majors might be harmful to work groups because the members of the group have similar background knowledge and ways of thinking in their field of study.

To estimate the level of creativity of individuals and groups, this study used divergent thinking, a critical component of creative thinking. It measured the quantity, diversity and novelty of ideas that people generated in a specific task. The study was an initial investigation to determine the role of diversity of academic major in group and individual divergent thinking.

Literature Review

Creativity and Divergent Thinking (DT)

Divergent thinking (DT) is an important construct in creativity study. It is not the same as creativity thinking, but specifically focuses on the originality of thoughts which is the central feature (Guilford, 1968) and is a useful indicator of creative thinking (Runco & Acar, 2012). Researchers often use brainstorming (Diehl & Stroebe, 1991; Saad, Cleveland, & Ho, 2015) in the group study of DT because it fills the gap between the creative cognitive process and a creative product. DT is also a critical part of the problem solving process because in real life

problems typically have more than one solution, as opposed to convergent thinking which is the quest for a single solution.

Creativity in Group Work

In the last decade, research in social science has begun to develop a new approach to explain the emergence of new ideas from human activity. This mechanistic approach (Bechtel, & Richardson, 1993) explains not only the regularity in individual mental processes, but also explains the interactional processes among the participants (Sawyer, 2010). Sawyer (2003b) studied the mechanisms of collaborative emergence in small groups. These small groups worked together without an assigned "leader" to finish the task (for example, to perform a play in a theatre). All of the actions were improvisational and everything was intentional. Sawyer observed and took note of each action as well as the dialogue from this process and concluded that creativity outcomes were generated from the interaction of individuals. However there are more questions that need to be explored: Can the "audience" foster an individual's creativity in a group and how? Since everyone is different, which part of this human diversity affected others in the group?

Creativity and Diversity

The idea that diversity can promote creative and innovative outcomes for organizations is widely accepted today (McLeod, Lobel, & Cox, 1996); groups would not be able to innovate without the creative ideas of their members. Though many have suggested the beneficial outcomes of divergent environments (Cox, Lobel, & McLeod, 1991; Mcleod, Lobel, & Cox, 1996), there is relatively little research into the relationship between creative thinking and diversity. Exploring relationships between DT and group work outcomes, before understanding the thinking processes that take place during collaborative work, is unwise.

Recent trends from studies that investigate diversity in group settings have led to an emphasis on different components of diversity. Today, no study has directly demonstrated that diversity of academic major might be an essential factor to influence the emergence of creative ideas in a group. Nevertheless, since graduate students have strong background knowledge and skills in their own unique field of study, findings showing the positive effects of knowledge diversity, established in group creativity studies (Milliken, Bartel, & Kurtzberg, 2003; O'Reilly, Williams, & Barsade, 1998), can be considered indirect evidence. Other studies provide evidence for additional kinds of diversity: culture and ethnic, gender, knowledge and skills, and perspectives and will be discussed below.

Groups with Divergent Culture. It is the fact that as the global economy develops, it is inevitable for people to work, study or live in multicultural environments. Intergroup contact theory (Pettigrew, 1998) states that engaging in interactions with other social groups improves one's attitudes toward diversity through the processes of learning about dissimilar others. Lin (2014) studied the interpersonal conflict and creativity in multicultural environments. The results showed that the group creativity would be enhanced if the conflict that was not interpreted as a threat (dissent without the threat) occurred in the group with diverse cultures. Wang (2012) employed language-retrieved pictures that are relevant to the ongoing conversation in groups to determine how interactions among individuals from different cultures supported intercultural brainstorming. Although this study focused on the mediation of machine translation (MT) in group work, it provided evidence that working in a bilingual group can increase the group's DT during brainstorming.

Groups with Divergent Ethnicity. In educational settings, when students were assigned to engage in a discussion in a racially diverse group, they exhibited more integrative complexity

than did those in a homogeneous group (Antonio et al., 2004). The ideas produced by ethnically diverse groups are more effective and feasible than those produced by homogeneous groups (McLeod, Lobel, & Cox, 1996). In contrast, ethnic diversity has been found to have no significant effect on the creativity of collectively developed story endings in (Paletz, Pend, Erez, & Maslach, 2004).

Groups with Divergent Gender. Diversity mindsets also appear to moderate the effect of gender diversity on collaborative creativity (Pluut, & Curşeu, 2013). However, the Diehl's (1991) study provided contrary results, suggesting that that group work generated lower performance levels than individual work, both in terms of the quality and quantity of ideas that were generated; and the performance of a same-sex group didn't show a significant difference between homogeneous groups.

Group with Divergent Knowledge and skills. Diversity of knowledge and skills will contribute to team innovation dependent upon the sophistication of group processes (O'Reilly, Williams, & Barsade, 1998). A study on deep-level diversity (opinions, attitudes, information and values) pointed out that deep-level diversity leads to products with less elaborated and integrated ideas; meanwhile, several unusual ideas are produced (Harvey, 2013).

Groups with Divergent Perspectives. In groups with different perspectives, especially the occurrence of minority and novel perspectives, the exploration of alternative ideas for solving problems will be increased (Nemeth, 1991). Research conducted by Van Dyne and Saavedra (1996) used a longitudinal design to examine the Nemeth (1986) model of minority influence in natural work-groups. This research provided substantial support for Nemeth (1986) model that the individuals who were exposed to minority perspectives will think divergently. In this way, the individuals will exert more cognitive effort and the group will be less narrowly focused. This

study also demonstrated that encouraging expression of minority viewpoints helped groups make higher innovative and quality decisions.

Summary. Sawyer (2003) described the interpersonal connection within a music band during a performance as "an intangible chemistry between the members of the group" (Sawyer, 2003, p.4). Considering all of the previous studies on relationship between diversity and creative outcomes, the clues of the specific environment in which this "intangible chemistry" occurring has been provided: group diversity. According to Pettigrew (1998), Lin (2014) and Wang's (2012) studies, group creativity could be enhanced by working with dissimilar others in multicultural environment. Additionally, divergent knowledge, skills and perspectives in group encourage individuals to consider alternative perspectives and express minority viewpoints (Van Dyne & Saavedra, 1996; Nemeth, 1991). The more cognitive effort that individuals exert during group work, the more unusual, and relevant solution or high quality ideas will be generated.

As an important way to obtain knowledge of a specific field of study, academic major can be a target factor that might provide empirical evidence for the study of diversity and creativity. It could also benefit a school's curriculum. There has been little work that investigates the diversity of academic major on creativity, the purpose of this study. This study will analyze the effects of diversity of academic major on creativity during a problem solving activity and collect the score of three essential components of DT – fluency, flexibility and originality.

Research Questions and Hypotheses

Members of a group that have different academic majors have access to diversified knowledge and skills. A more diverse group is likely to have the potential to stimulate the

cognitive process for individuals' DT and the emergence of divergent ideas. The first purpose of this study was to extend previous research that has clearly revealed a substantial relationship between creativity and group diversity, especially in adult groups. However, no study has discussed the value of diversity of academic major in a group of graduate students. Communicating with individuals who have a dissimilar background of knowledge and skills would expose graduate students to other ways of thinking and new perspectives. It might stimulate the creative cognitive process and help them produce new ideas. The other objective of this study was to examine whether diversity of academic major in graduate student groups can foster divergent thinking for both groups and individuals.

Based on these arguments, the following two main questions were addressed.

Research Question 1: Will groups with divergent majors generate higher mean levels of divergent thinking during group work than groups with a common major?

Research Question 2: Will individuals who worked in a group with divergent majors generate higher mean levels of divergent thinking after group work than individuals who worked in a group with a common major?

Method

Participants

The participants in this study were recruited from graduate students at the University of Connecticut. The total sample ($N = 56$) included 36 female and 20 male students in their first through sixth year of graduate study (mean graduate years = 2.2; $SD = 1.0$) who ranged in age from 22 to 40 years (mean age = 26.6; $SD = 3.6$). 42.9% of the participants were native English

speakers or bilingual, with English and another language, and 57.1% of participants were not native English speakers (Chinese, Korean, Portuguese, Arabic, Sinhala, Hindi, Telugu, Bengali, German, Persian, and bilingual with Romanian and Serbian).

Participants were assigned into one of two groups based on their academic major. Initially, student majors were categorized into one of six clusters of majors based on the RIASEC model as outlined by Holland (1997). There were 4 participants with Realistic (R) majors (architecture, civil engineering, geology and physical therapy), 14 with Investigative (I) majors (science and engineering), 2 with Artistic (A) majors (German and linguistics), 20 with Social (S) Majors (education, health science, and human development study), 11 with Enterprise (E) majors (Business, management, and economics), and 5 with Conventional (C) majors (Statistics, measurement evaluation and Assessment, and computer science). Second, participants were assigned to one of 28 groups to work with another graduate student. 14 groups consisted of two students with a common major and 14 groups consisted of two students with majors from different categories. The divergent major group (DMG) will be used to describe the groups which contained two participants from different majors, and the same major group (SMG) will be used to describe the groups consisted of two participants from same major.

Demographic information for DMG and common major group (age, gender, native language, RIASEC major category and the year of graduate study) are shown in Table 1. During the procedure used to assign participants, students from a program in gifted and talented were not selected because they had learned about this test in their courses.

Measures

Alternate Uses Test (Guilford, Christensen, Merrifield, & Wilson, 1978). The Alternate Uses Test (AUT) is a means of evaluating DT abilities. It requires subjects to list all

unusual uses for common objects in the time allowed. It was original designed as the *Unusual Test* (Wilson, Guilford, Christensen, & Lewis, 1954) to represent "flexibility of thinking", which is a critical part of the creative design process. The AUT uses the revised and improved form (Guilford, Christensen, Merrifield, & Wilson, 1978). This revised version asked participants to think of a fixed number of ideas (as many as six).

Currently, the test requires subjects to list all of the possible unusual uses for several common objects. For example, to answer the question of "List uses for a paperclip" a participant might come up with the following answers: removing materials from small spaces; puncturing through something; removing food from teeth; testing a cake for doneness; holding paper together and sticking someone. Then the test score is determined from the number of original answers.

As a subtest of the Torrance Test of Creativity Thinking (TTCT), which was developed by Torrance (1972), the AUT is a reliable indicator of creativity potential (Runco & Acarm, 2012). In Runco and Acarm's report (2012), the test-retest reliability for adults is .75 with six items, .82 with nine items and .86 with 12 items. Results show that adults have higher reliability in test-retest than sixth and ninth grade students (Guilford, Christensen, Merrifield, & Wilson, 1978). Twelve items for individual tests were chosen from the manual of instructions and interpretations for the AUT (Guilford, Christensen, Merrifield, & Wilson, 1978). The test also has good predictive validity with multivariate correlations of .63 with creative achievement (Torrance, 1972). The AUT was initially designed for individuals and asked participants to finish several items within a time limit. This study modified the number of items and the time limit only during group activity, not for the individual tests. Groups were allowed to communicate

with their partners and finish each item in four minutes during group activity. This modification enabled them to have enough time to discuss responses..

Procedures

Preparation for the test. Test information, including the time of the experiment (around 30 minutes), introduction, procedures, and purpose of the test were provided to all participants before the test.

Materials. The materials for the test were pencils, papers, pictures for test items, and a stopwatch.

Individual pre-test. The pre-test was completed individually. After a short introduction, all of the participants were asked to respond to four different items (for example, list as many unusual uses for shoes) within 6 minutes (3 minutes for the first two items, and 3 minutes for the next two items).

Group activity. After a short introduction for the group activity, each group was asked to work together to respond to a total of four different items in 16 minutes (4 minutes for each item).

Individual post-test. During the post test, each participant was asked to respond to four different items within 6 minutes (3 minutes for the first two items, and 3 minutes for the next two items).

All the items are listed below in Table 2. Every item came with a example use to clarify the items. The test paper is provided as Appendix 1.

Scoring

The scoring system used in the AUT is also used in other creativity tests including the Torrance Test of Creativity Thinking (TTCT) (Dippo, 2013). This study collected three scores:

fluency (quantity of items), flexibility (number of different categories), and originality (number of uncommon ideas).

Fluency score. First, a fluency score is calculated on the basis of the number of distinct and acceptable responses generated for each item. For example, in response to the question of "List uses for a paperclip" mentioned above, the fluency score would be 6. The participant who lists more responses will have a higher fluency score. The fluency score reveals the ability to produce a number of figural images. However, if the answer is too vague or unacceptable (for example, use a paperclip to play, or use a paperclip to cover bed, etc.), this answer will not be scored.

Flexibility score. Second, a flexibility score is calculated on the basis of the number of different categories into which responses fall. Responses were generalized into a single keyword that will categorize similar answers. In the example of listing the uses of a paperclip, "removing materials from small spaces" and "puncturing through something" would be categorized into "using a paperclip as a pick." If a participant generates more categories of answers, the flexibility score will be high.

Originality score. Third, the originality score is the number of infrequent ideas, that is, the number of uncommon ideas that emerge for each item. The originality score shows the ability to produce uncommon or unique responses. Dippo (2013) evaluated the Alternative Uses Test of Creativity and defined the original answer in this test as *the response with low percent of occurrence*, which was mentioned by fewer than 10% of participants or groups. According to Dippo's (2013) scoring method, the original answer in this study was defined as the response which was mentioned by fewer than 10% of 56 participants during individual pre-test and post-test, and the response which was mentioned by fewer than 10% of 28 groups during group

activities. Once the answers were categorized into different categories, the responses were documented. The scoring procedure counts the most common responses as 0 and all other legitimate responses as 1. For example, the answers and the frequency of occurrence for shoes are “smash bugs (40); hat (2); dry up puddle (1); make an ant house (6).” Because 2 of 56 individuals answered “hat”, and 1 of 56 individuals answered “dry up puddle”, the answer of “hat” and “dry up puddle” have the statistical infrequency of occurrence lower than 10% of 56. Thus, in this example, the score of originality will be 2. The scoring keys are provided in the Appendix 2.

Table 3 presents the means and standard deviations of fluency, flexibility and originality scores for each item in the individual test, and two composites (individual pre-test and individual post-test) across group type (DMG and SMG). The score of the pre-test is the average of the scores of four items in individual pre-test: shoes, button, key and wooden pencil. The score of post-test is the average of the scores of four items in individual post-test: safety pin, bed sheets, milk carton and nail.

Additionally, the means and standard deviations of the fluency, flexibility and originality scores of each item and the total score in the group activity of two groups are provided in Table 4. The *composite score* is the average of the scores of four items in the group activity: automobile tire, eyeglasses, chair and watch.

Analysis

Research Question One: Will members of a group with divergent majors generate higher mean levels of divergent thinking during group work than members of a group with a common major?

To explore Research Question One, the multiple t test was conducted to evaluate the hypothesis that students in the DMG would generate higher DT scores (fluency, flexibility and originality score) opposed to students in the group with a common major . A Bonferroni correction was used in the analysis. The Bonferroni correction is a method used to counteract the problem of multiple comparisons. When determining statistical significance, the risk of a Type I error was reduced by applying a Bonferroni correction to all three equations.

Research Question Two: *Will individuals who worked in a group with divergent majors generate higher mean levels of divergent thinking after group work than individuals who worked in a group with a common major?*

To explore Research Question Two, the dependent variables were the difference between the post-test and pre-test of these three quantities, namely, the change scores of fluency, the change scores of flexibility, and the change scores of originality. A multiple t-test (alpha level of .05) with Bonferroni correction was used to evaluate if there would be a significant difference between the means of pre and post scores on each of the three measures. When determining statistical significance, the risk of Type I error was reduced by applying a Bonferroni correction to all three contrasts.

Supplemental questions: Will the level of divergent thinking change in the divergent major group during the four time periods of group activities? Will the level of divergent thinking change in the common major group during the four time periods of the group activities?

A two-way within-subjects analysis of variance was conducted to evaluate the effect of group types and time period for three DT outcomes. The dependent variables were three different scores: fluency, flexibility and originality. The within-subjects factors were group types with two levels (DMG and common major group) and time with four levels (4 minutes, 8 minutes, 12

minutes and 16 minutes). The time main effect and group type x Time interaction effect were tested using the multivariate criterion of Wilks's lambda (Λ).

Results

Will members of a group with divergent majors generate higher mean levels of divergent thinking during group work than members of a group with a common major?

In the first analysis, the test was significant only on mean scores of originality, $t(26) = 2.378$, $p = .025 < .05$. Participants in DMG (Mean = 2.4, SD = 1.2) demonstrated significantly higher mean originality scores than those in the common major group (Mean = 1.4, SD = 0.9). The 95% confidence interval for the difference in means ranges from 1.33 to 1.83. The mean fluency score ($t(26) = 1.221$, $p = .233$) was not significantly between the two groups, as was the flexibility score ($t(26) = .799$, $p = .432$). Table 5 provides the results of t-test and descriptive information.

Will individuals who worked in a group with divergent majors generate higher mean levels of divergent thinking after group work than individuals who worked in a group with a common major? In the second analysis, the test was significant, favoring individual students who worked in the group with divergent majors, on the mean of the change scores of fluency ($t(54) = 2.307$, $p = .025 < .05$). Participants in the DMG (Mean = 1.6, SD =1.0) had significantly higher change scores of fluency than those in the common major group (Mean = 1.0, SD = 0.9). Another notable result is the DMG performed significant higher mean scores of the change scores of originality ($t(54) = 4.436$, $p = .000 < .05$). It is worthwhile to note that participants in the DMG (Mean = 0.6, SD = 0.7) generated more original ideas in the post-test than in pre-test, in contrast, the common major group (Mean = -0.1, SD = 0.5) generated

lower mean scores in the post-test than the pre-test. The results of the t-tests and descriptive information of the group test are shown in Table 6.

The magnitude of these comparisons of mean difference appears to represent a substantial effect size (Cohen, 1992). The magnitude for the comparison of originality in the individual test represents a large effect size (Cohen's d = 1.15) which provides 0.98 power. And the magnitude of the group originality score represents a large effect size (Cohen's d = 0.98) which provides 0.67 power.

Will the level of divergent thinking change in the divergent major group during the four time periods of group activities? Will the level of divergent thinking change in the common major group during the four periods of the group activities? In the analysis of the supplemental questions, the time main effect for fluency scores was significant ($\Lambda = .07$, $F(2, 8) = 46.84$, $p < .05$), but the group main effect and Group x Time interaction were not significant. Similarly, the time main effect for flexibility scores was significant ($\Lambda = 0.10$, $F(2, 8) = 34.59$, $p < .05$), however the group effect and Group x Time interaction were not significant. Unlike the fluency and flexibility scores, the group main effect for originality was significant ($\Lambda = .70$, $F(2, 8) = 5.52$, $p < .05$). However, the univariate test associated with the time main effect was not significant and it was not significant for the Group x Time interaction effect. The results of the two-way within subject analysis are provided in Table 7.

A multiple regression analysis was also conducted as an additional analysis to evaluate how well the type of group (set 1) predicted the increase of fluency, flexibility and originality scores, and how well the other four demographic variables (set 2) – gender, age, year of graduation and language background – predicted those three DT performance over and above the type of group. The results of this analysis indicated that group type accounted for a significant

amount of the increase of fluency score (R^2 = .06, F (1, 55) = 5.32, p < .05). The demographic status did not predict significantly over and above the group type, R^2 change = .06, F (4, 50), p = .53. Both group type (R^2 = .06, F (1, 55) = 3.19, p = .08) and demographic status (R^2 change = .09, F (4, 50) = 1.33, p = .27) were not significant on flexibility. The group type was significant predict the increase score of originality, R^2 = .27, F (1, 55) = 19.68, p < .05, meanwhile the demographic status didn't show significant on predicting the increase of originality scores, R^2 change = .06, F (4, 50) = 1.18, p = .33. Based on these results from multiple regression analysis, the demographic variables (gender, age, year of graduation and language background) didn't account for a significant amount of the increased scores of fluency, flexibility and originality. The group type is the only variable that appeared to influence the increased scores of creative performances. The summary of results for the regression analysis are provided in Table 8.

Discussion

Prior studies argued that it is necessary for group work to value and take diversity into consideration as an essential and desirable component for fostering group and individual creativity (Page, 2007). As one of the first to examine the value of diversity in group, the focus of the current study was more specific. It examined the role of diversity of academic major in influencing individual and group creativity. A standard test of divergent thinking (DT), entitled Alternate Uses Test (AUT), was used to collect the responses from 56 individuals and 28 groups. The three outcomes for DT performance, fluency (quantity), flexibility (categories) and originality (novelty) scores, were rated from these responses.

The findings showed that the groups which contained divergent majors demonstrated more original ideas than the same major group (SMG) during a group activity. Additionally, the

divergent major group (DMG) also had higher change scores of fluency and originality than the SMG, which could suggest that working collaboratively with a person from a different major might help people make greater progress on generating new ideas with high quantity and high novelty. These results are important because it is a preliminary experiment for examining the role of academic diversity in a group to support divergent thinking. Moreover, these results provide support for the research hypothesis that academic diversity can foster both individual and group divergent thinking and, perhaps, creative thinking.

As we can see in Table 4 and 5, the DMG had a significantly higher mean score (Mean = 2.4, SD = 1.2) on originality than the SMG (Mean = 1.4, SD = 0.9) during group work. However, the mean scores of fluency and flexibility did not show a significant difference between the two groups. This suggests that groups containing divergent majors appear to have greater potential to generate more novel ideas than groups consisting of people from similar majors. Meanwhile they might also produce similar outcomes in the number of ideas and the number of the categories. The analysis for the individual tests showed that participants who worked in divergent groups performed significant better on the change scores of fluency and originality than individuals who worked in the SMG.

It appears that the three outcomes of DT – fluency, flexibility and originality – may be directed at different DT processes. Even though there is no consensus on which component is the most effective indicator for creative thinking, it has been suggested that originality is more closely tied to creativity compared to other components (Runco & Albert, 1985). It is no doubt that participants in DMG were more likely to experience creative feedback from their partners than those in SMG. The alternative perspectives from peers, as Kim (2014) said, helped them get out of their limited frame of thinking. They reconstructed their “pool of ideas” during the group

activity and they completed the post-test by using this new approach. It is not hard to explain why people from DMG could generate more novel idea than those in SMG after group activity.

The results from the supplemental analysis for group activity through different time periods (4 minutes, 8 minutes, 12 minutes and 16 minutes) shows somewhat different patterns on fluency, flexibility and originality scores. The time effect was significantly different on fluency and flexibility scores, but not significant for originality. This suggests that fluency and flexibility scores varied through different times, but originality scores appeared more stable. The group effect was significant only on originality scores,, suggesting that these two types of groups (divergent or SMG) had different patterns of scores through four times.

This study highlights the benefits that working in groups with people from different majors has on both individuals and groups. Although creative things are more than just original (Runco & Charles, 1993), originality is more closely tied to creativity than fluency and flexibility (Runco & Albert, 1985). Originality is the most widely respected trait in the creativity complex (Barron, 1995; Runco & Charles, 1993; Sternberg, 1999). These findings also provided partial experimental confirmation of the claims from prior studies and corroborate the general notion that groups could be more productive when different kinds of individuals work together (Page, 2007). Overall, these results provide substantial support for the research hypothesis that academic diversity can foster both individual and group creative thinking.

Limitation And Future Research

Several limitations of this study should be considered and several future directions are worthwhile to study. First, although the effect size provided acceptable power, the sample size was small. There were only 56 participants in the individual test and only 28 groups in the group activity, which means the estimated power of the sample size was .57 before the test with an

estimated medium effect size . Prior research showed unacceptable results when using a small sample size. The Hoffmann and Russ' (2012) study of the relationship between pretend play and creativity (they used AUT to test DT and creativity) indicated that 64 participants provided .80 power for a medium effect size (Cohen, 1992). In another study, Rose and Lin (1984) organized data from 46 creativity studies which used a DT test (measured by the AUT as the part of Torrent Test of Creativity), and provided a mean effect size of .60. This power analysis indicates the sample size in this study may not be optimal to fully detect any significant differences. Nevertheless, it is worthwhile to have this early study in order to evaluate the measures and improve the methodologies for future research.

In addition, the participants were neither randomly selected from graduate students, nor randomly assigned to groups. In the future research, a computer or mobile phone could be used to administer the test to randomly assigned groups. That might be more convenient for participants to attend the test and it will be more likely to recruit more participants and to make sure there are equal numbers of participants from each category (RIASEC) of academic majors.

Second, although most graduate students who were not native English speakers already had good English skills as a second language to support their study, some of participants needed translation during the test, and many of them tried to use illustrations instead of written or oral expression to explain their thoughts. In addition, during the group activity, some participants provided more detail when they expressed their thoughts orally than when they wrote down the answers. For example, one of participants said, "Circus use nails to play show, like many nails stick on wood board", but wrote down "nails bed" on the test paper. There was a study analyzing oral rather than written expression during solving divergent thinking problems. Khandwalla (1993) encouraged participants to think aloud while trying to solve DT task, and the protocols

were recorded and analyzed. Future work might compare the different ways of expression on DT performance.

Finally, the current study was administered within a short period of time (30-40 minutes). If a longitudinal study of students who stay in a steady group for a longer duration could be conducted, it might better reveal the impact of students' diversity on individual and group creativity.

As Page said, "the business world has become more global … the homogenous hierarchy has given way to the diverse team" (2007, p. xxi). As graduate students, producing original research is a significant goal. To achieve this goal, thinking differently is required. Graduate school should take academic diversity into consideration when they design the curriculum and instruction of courses for students, to enable the divergent environment. Like Imperial College London, providing a dissent-friendly community for graduate students is a possible goal for academic institutes to help students to become more successful in their field of study.

Tables

Table 1
Demographics

	Common Major	Divergent major
N	28	28
Age		
Mean	26.86	26.36
SD	2.97	4.16
Year of Grad		
Mean	2.29	2.14
SD	0.98	1.11
Sex (% male)	39.3	32.1
Native Language		
English	32.1	53.6
Other	67.9	46.4
RIASEC		
R	0	14.3
I	28.6	21.4
A	7.1	0
S	35.7	35.7
E	21.4	17.9
C	7.1	10.7

Note. Except for sample size (n), age, and year of grad, data are reported as percentages.

Table 2
Test Items

Test	Items
Individual Pre-test	1. Shoe
	2. Button
	3. Key
	4. Wooden Pencil
Group Activity	5. Automobile Tire
	6. Eyeglasses
	7. Chair
	8. Watch
Individual Post-test	9. Safety Pin
	10. Bed Sheet
	11. Milk Carton
	12. Nail

Table 3.
Group Means and Standard Deviations on Subtest and Composite Scores of Pre and Post Individual Tests

	Common Major		Divergent major	
	Means	SD	Means	SD
Shoes				
Fluency	4.6	2.0	5.1	2.3
Flexibility	4.2	1.9	4.6	2.1
Originality	1.1	1.0	1.4	1.4
Button				
Fluency	3.6	1.7	3.9	2.1
Flexibility	3.4	1.5	3.2	1.7
Originality	1.2	1.1	1.0	0.9
Key				
Fluency	3.6	1.4	4.3	2.0
Flexibility	3.4	1.3	3.6	1.3
Originality	1.0	0.8	0.8	0.8
Wooden Pencil				
Fluency	3.8	1.6	3.6	2.0
Flexibility	3.8	1.6	3.4	1.8
Originality	1.8	1.1	1.7	1.2
Safety Pin				
Fluency	4.8	1.5	6.2	2.3
Flexibility	4.5	1.3	5.5	1.8
Originality	1.3	0.7	1.8	1.3
Bed Sheets				
Fluency	6.1	2.2	7.3	2.4
Flexibility	5.8	2.1	6.4	2.3
Originality	1.0	0.8	1.8	1.6
Milk Carton				
Fluency	4.8	1.7	4.8	2.0
Flexibility	4.4	1.7	4.3	1.8
Originality	1.0	1.1	1.6	1.1
Nail				
Fluency	4.1	1.7	5.1	2.4
Flexibility	4.0	1.5	4.3	1.9
Originality	1.4	0.8	2.1	1.5
Pre-Test				
Fluency	3.9	1.3	4.2	1.6
Flexibility	3.7	1.2	3.7	1.3
Originality	1.3	0.7	1.2	0.8
Post-Test				
Fluency	4.9	1.2	5.8	1.7
Flexibility	4.7	1.2	5.1	1.5
Originality	1.2	0.5	1.8	1.1

Note. The score of pre-test is the average of the scores of shoes, button, key and wooden pencil. The score of post-test is the average of the scores of safety pin, bed sheets, milk carton and nail.

Table 4.

Group Means and Standard Deviations on Subtest and Composite Scores of Group Activitys

	Common Major Group		Divergent major Group	
	Means	SD	Means	SD
Sub Standard Scores				
Automobile Tire				
Fluency	11.0	3.4	10.3	3.2
Flexibility	10.8	3.3	9.9	2.9
Originality	2.1	1.4	2.1	1.2
Eyeglasses				
Fluency	9.6	3.4	10.4	3.7
Flexibility	9.3	3.0	9.9	3.6
Originality	1.4	1.1	2.6	1.6
Chair				
Fluency	12.1	2.8	14.9	4.1
Flexibility	11.9	2.7	13.9	3.8
Originality	1.0	1.1	2.4	1.6
Watch				
Fluency	11.1	3.3	13.6	5.1
Flexibility	10.6	3.7	12.1	4.1
Originality	1.0	0.8	2.4	1.4
Composite Standard Scores				
Group Activity				
Fluency	10.9	2.8	12.3	3.0
Flexibility	10.6	2.7	11.5	2.7
Originality	1.4	0.9	2.4	1.2

Note. The composite score is the average of the scores of automobile tire, eyeglasses, chair and watch.

Table 5

Results of t-tests and Descriptive Statistics Fluency, Flexibility, and Originality by Group

Outcome	Group				95% CI for Mean Difference			
	Divergent major Group		Common Major Group					
	M	SD	M	SD		t	df	Sig. (2 talied)
Fluency	12.3	3.0	10.9	2.8	-0.92, 3.59	1.22	26	.233
Flexibility	11.5	2.7	10.6	2.7	-1.29, 2.94	0.80	26	.432
Originality	2.4	1.2	1.4	0.9	0.13, 1.83	2.38*	26	.025

* $p < .05$.

Table 6

Results of T-tests and Descriptive Statistics the Difference Between the Posttest and Pretest of Fluency, Flexibility, and Originality by Group

Outcome	Group				95% CI for Mean Difference			
	Divergent major Group		Common Major Group					
	M	SD	M	SD		t	df	Sig. (2 talied)
DifFluency	1.6	1.0	1.0	0.9	0.75, 1.07	2.31*	54	.025
DifFlexibility	1.4	0.9	1.0	0.9	-0.05, 0.91	1.79	54	.080
DifOriginality	0.6	0.7	-0.1	0.5	0.39, 1.04	4.44*	54	.000

* $p < .05$.

Note. DifFluency, DifFlexibility and DifOriginality are the difference between the posttest and pretest of these three quantities.

Table 7

ANOVA Table for Repeated Measured

		Wilks' Lambda Value	F	Hypothesis df	Error df	Sig.
Fluency						
	Group	.93	.97	1	13	.34
	Time	.073	46.84*	3	11	.00
	Group*Time	.057	2.76	3	11	.09
Flexibility						
	Group	.97	.42	1	13	.53
	Time	.10	34.59*	3	11	.00
	Group*Time	.59	2.59	3	11	.11
Originality						
	Group	.70	5.52*	1	13	.04
	Time	.61	2.33	3	11	.13
	Group*Time	.53	3.29	3	11	.06

* $p < .05$.

Table 8

Multiple Regression Analysis of Factors Related To Three DT Outcomes

					Change Statistics				
	R	R Square	Adjusted R Square	Std. Error of the Estimate	R Square Change	F Change	df1	df2	Sig. F Change
Fluency	.30[a]	.09	.07	.93	.09	5.32	1	54	.025
	.38[b]	.15	.06	.93	.06	.80	4	50	.530
Flexibility	.24[a]	.06	.04	.90	.06	3.19	1	54	.080
	.38[b]	.15	.06	.89	.09	1.33	4	50	.274
Originality	.52[a]	.27	.25	.60	.27	19.68	1	54	.000
	.58[b]	.33	.26	.60	.06	1.18	4	50	.331

a. Predictors: (Constant), GroupType

b. Predictors: (Constant), GroupType, Year of graduation, Gender, Language Background, Age

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Appendix 1: Test Papers

Form A: Pre-test

Major		Year/Degree	
Gender	M / F	Age	
Native Language			
Date	[Click to select date]		

In this test, you will be asked to consider some common objects. Try to list as many uses as you can for this common object.

Example: A NEWSPAPER. You might think of the following uses for a newspaper:

Start a fire

Wrap garbage

Swat flies

Stuffing to pack boxes

Line drawers or shelves

Make up a kidnap note

…

You will have 3 minutes to complete first 2 items, and another 3 minutes to complete other 2 items.

Notice that all of the uses listed are different from each other. Do not spend too much time on any one item. Write down those uses that occur to you and go on to the next one.

If you have any question, ask now.

Part 1

Shoe (example: used as footwear)

Button (example: used to fasten things)

Part 2

Key (example: used to open a lock)

Wooden Pencil (example: used for writing)

Form B Group Activity

You will work with your partner to finish 4 items within 16 minutes. You will have 4 minutes to complete each item. You can both write down the answer on this big paper.

1. Automobile Tire (example: used on the wheel of an automobile)
2. Eye Glasses (example: used to improve vision)
3. Chair (example: used for sitting)
4. Watch (example: used for telling time)

Form C: Post-test

Part 3

Safety Pin (example: used for fastening)

Bed Sheet (example: used on bed)

Part 4

Milk Carton (example: used to hold liquid)

Nail (example: used for fastening)

Appendix 2: Scoring Key

From experience in scoring this kind of test, a number of rules have been adopted. These rules are given below, followed by specific examples of acceptable and unacceptable responses to items.

1. The scorer should mark all responses (stated use) either acceptable (1) or unacceptable (0).

2. A use, to be acceptable, should be possible for the object. For example, stating that an automobile tire can be used as a ring for the finger is unacceptable under this rule.

3. An acceptable use must be different from the given use, i.e., it must not fall within the class of the given, common use. The scorer should tend to leniency in this regard, however, a response being ruled out only if it is clearly just a modification of the given use. Saying that a milk carton can be used to "hold orange juice" is not sufficiently different from "used to hold milk," which is given. On the other hand, the use "to mix paints in" involves more than the idea of containing and therefore qualifies.

4. Where the same idea of use may be more than one object, e.g., "as a weapon" or "to burn," credit should be given for each response unless some use is obviously overworked, particularly with the same wording.

5. Vague or very general uses are not acceptable. Examples of such responses are listed below. Note, however, that some seemingly vague responses are listed as acceptable.
This is for the reason that they pertain to some unusual, specific attribute of the object.

6. A use that pertains to any conceivable interpretation of the object is acceptable. For example, "shoe" is not only footwear; it may also be part of a brake. A "button" not only appears on clothing, it can be a symbol as for a campaign or a club. A "key" not only unlocks doors; it may belong to a test or a map.

Lists of Responses*

The lists of uses for the various items have accumulated in experiences with the Unusual Uses Test. They are meant to serve as guides, not to be followed unquestionably. The scorer may find occasional responses that are acceptable under the rules that do not appear in the list. Under the rules, some responses, although listed, should not be given credit, for example duplicating uses.

Examples of responses that are too vague to be accepted:

To have fun with, as a game, to break, to use the parts, to make something, to throw it (except shoe), as a weapon (except shoe), to hit with (except shoe), to burn, to throw away, to get.