An Exploratory Study of Variability among Types of Creativity before and after a Two-week Intervention

By

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Abstract

Creativity and learner variability are both recognized as important for today’s education context. Learner variability and creativity cannot be reduced to single dimensions or only account for cognitive traits. Therefore, this study explored cognitive, noncognitive, and background variables together to understand how types of creativity vary within the treatment sample and how malleable those creativity types are.

Participants included 201 adolescent individuals (11-18 years of age) from China, the United States, England, and Australia. These participants took part in a two-week treatment focused on fostering innovation, creativity, and entrepreneurial mindsets. Participants took the Kaufman Domains of Creativity Scale (K-DOCS) at the beginning and end of the treatment, identifying dominant domains of creativity. Demographic data was also collected at these times. Additional English language proficiency measures were utilized for non-native speakers. Consistent with understandings of learner variability, trends for association with creativity and changes across domains were diverse for groups and subgroups. Some cultural and gender stereotypes appeared evident in memberships across creativity domains. Additionally, potential treatment interactions could account for certain domain associations as well as domain changes and apparent side effects. English language ability, as a relevant cognitive aptitude, seemed to play a negligible role as measured within the study. Additionally, analysis of potential negative associations with the treatment found significant variability; however, some creativity types may have experienced negative trends to do treatment interactions. This research confirmed the variability that can be in creativity and highlighted trends across culture, gender, and treatment interactions, providing avenues for future exploratory and experimental analyses.

Keywords: learner variability, creativity, creativity domains, interaction, aptitudes
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Chapter 1 Introduction

The twenty-first century brought with it rapid societal, economic, and technological shifts worldwide. These changes are characterized by innovations such as the ubiquitous nature of internet-enabled devices, advanced robotics and AI, Big Data, crowdsourcing, nanotech and biotech, and a shared, global economy (Bloem et al., 2014; Bonciu, 2017; Chala & Poplavska, 2017; Cotet et al., 2017; Kim, 2016; Manu, 2016; Tilak & Singh, 2018; Vishneva, 2018; World Economic Forum, 2018). These changes have created an environment that requires different ways of thinking, working, and learning (Chala & Poplavska, 2017; Pistrui & Kleinke, 2019). At the center of this global movement is a demand for a society that is increasingly creative. Individuals must be more creative, be able to creatively think, creatively problem solve, and embed creativity across subject areas and professions (Chala & Poplavska, 2017; Manu, 2016). This pervasive need for creativity inevitably impacts education. Education systems worldwide have recognized the need to cultivate and promote creativity in their students (Chu et al., 2017; Cotet et al., 2017; European Parliament and Council of the European Union, 2006; Gralewski & Karwowski, 2013; Guillard, 2016; Kim, 2016; Lamprini & Bröchler, 2018; McKay & Kaufman, 2020; Pistrui & Kleinke, 2019; Van Dam, 2017; World Economic Forum, 2016, 2018). As a result, there has been a significant increase in the interest in effective ways to develop creativity, and there have been efforts in both research and practice to boost creativity.

Despite the increase in interest and efforts in fostering creativity, effective ways to help students become more creative remain largely elusive. To date, there is limited consensus over what approaches and strategies are most effective in cultivating creativity (Davies et al., 2013; Gajda et al., 2017; Ritter & Mostert, 2017; Trotman, 2008) There are many reasons for this, including limited scope of implementations and multiplicity of definitions of creativity.
Historically, creativity in education has been seen as a feature of arts education. It is a trait or characteristic explored by students in music or art classes or a talent unique to those professionals who pursue music, painting, dance, or another visually artistic avenue (Hui et al., 2015; Moran, 2010). When it does venture outside this narrow scope, education systems have most often allowed its pursuit within gifted and talented programs. The exploration of creativity in gifted programs is seen as a way to expand opportunities for those who have proven themselves within the traditional classroom and can therefore be granted the time and challenge of pursuing more creative endeavors (Chan & Yuen, 2014; Ferrari et al., 2009; Makel, 2009; Moran, 2010).

However, today’s creativity as demanded by society extends further than these limited applications. Creativity is needed in science and mathematics, in innovation of current technology and in continued creation of new technology. It is found in sales and marketing and advertising, and it is found, regardless of profession in a call for creativity in dealing with open-ended problems and interpersonal skills (Čepić et al., 2015; Chala & Poplavska, 2017; Chu et al., 2017; Cotet et al., 2017; Guillard, 2016; Kim, 2016). If education is to address this diverse range of creative needs, it must counter the narrative that creativity is for the few or relevant only in elective areas. Instead, an expanded understanding of creativity is needed to integrate it across subject areas and domains.

The misconceptions and narrow applications of creativity in education are not surprising. Because the subject of creativity is not actually new, there exists a host of definitions and interpretations. Within these definitions and decades of research, creativity debates have ensued on par with academic debates like the “reading wars” or psychology debates such as behaviorism versus cognitivism. In creativity, these divisions have included splits over whether creativity is
an inherent trait or an acquired skill. Researchers have argued whether creativity is a general trait applicable across domains or varied and dependent based on specific domains. Some choose to define creativity according to the degree or level of creativity a person generically shows while others insist creativity is measured by proficiency in the skills associated with creativity (Acar & Runco, 2012; Barron, 1988; Gomez, 2007; Walton, 2003). This means that attempts to implement creativity programs and treatments in education have been as varied as the definitions themselves. What is important for educators to note, none of these definitions are inherently wrong; instead, “creativeness properly carries all these meanings and many more besides” (MacKinnon, 2017, p. 72). To address this wide array, educators need first a broad understanding of creativity and second must consider how these definitions interact within an education context.

Adding to the complexity is the nature of creativity. Creativity, like traditional cognitive aptitudes, is deeply personal. It depends on a range of individual variables, and it is subject to how well the environment enables or damages the individual’s potential growth trajectory (Abadzi et al., 2014). In other words, individuals develop creativity in different domains and follow different paths. Education programs that attempt to foster creativity may, therefore, have different effects on different individuals. Thus, it may be futile to search for a uniform approach to foster creativity in all students.

An alternate way to understand creativity in education is to explore context-dependent definitions – both of creativity itself and in defining success in treatments. It must be understood there is no singular approach to creativity education that works. Instead, creativity programs should ask how do groups, subgroups, and individuals vary within the treatment or program?
Who benefits from the treatment? Which individuals and what creativity talents and characteristics may actually suffer under the treatment?

This research sought to answer these questions through exploration of a specific treatment program that cited creativity development as one of its target goals. It explored a contextualized definition of creativity as domain-specific, understanding different individuals can be creative in different professional domains. It also explored other potential influential variables, recognizing there are cultural, cognitive, and multivariate factors that can contribute to or inhibit development of individual creative talents and traits.

Through this exploration, the research sought to understand, for the treatment’s goal of creativity, what patterns of domain-specific creativity can be found across groups and subgroups. Within these groups and subgroups, are there patterns of change in creativity, whether positive or negative? The goal of the exploration was to determine if there are different outcomes for different individuals or groups of individuals, recognizing the integrated patterns amongst cognitive and noncognitive variables interacting with the treatment. In such a way, it allowed the exploration of trends within the treatment without ignoring or reducing individual variability (Feldman et al., 1994). This study explored these layers of interactions from whole group to domain-specific groups to subgroups within domains. Each layer investigated the background variables, cognitive variables, and non-cognitive variables that could contribute to patterns and differences in creativity variability and how individuals experienced persistence or change within measured creativity domains. Through this exploration, this study sought to answer the following research questions.

**Research Questions**
1. How variable are types of creativity in this treatment with Chinese and non-Chinese adolescents?
   
a. What patterns in distribution across dominant domains of creativity are evident for education orientation at the beginning and end of treatment amongst the treatment participants?

b. What patterns in distribution across dominant domains of creativity are evident for gender at the beginning and end of treatment amongst treatment participants?

c. What patterns in distribution across dominant domains of creativity are evident for English language ability at the beginning and end of treatment amongst treatment participants?

d. What patterns in distribution across dominant domains of creativity are potentially attributed to treatment interaction amongst treatment participants?

2. How malleable are types of creativity in this treatment with Chinese and non-Chinese adolescents?

a. What patterns are evident for change of association with dominant domains of creativity?

b. What patterns in change (positive or negative) in degree of association with dominant and secondary domains of creativity are evident for education orientation from beginning to end of treatment?

c. What patterns in change (positive or negative) in degree of association with dominant and secondary domains of creativity are evident for gender from beginning to end of treatment?
d. What patterns in change (positive or negative) in degree of association with dominant and secondary domains of creativity are evident for English language ability from beginning to end of treatment?

e. What patterns in change (positive or negative) in degree of association with dominant and secondary domains of creativity are potentially attributed to treatment interactions from beginning to end of treatment?
Chapter 2 Literature Review

Creativity has always been identified as an integral part of the human existence. The abilities to reflect, transform and change set humans apart, as we use creativity to impact our environment to our own benefit. This includes analyzing surroundings to assess the negative impacts of past changes (Feldman et al., 1994; Moran, 2010). Creativity is seen as a uniquely beneficial trait for education and society at large. It fosters engagement, facilitates integration of ideas, is adaptable, and aids in the development of metacognitive skills such as self-regulation and smart risk-taking. It leads to personal and cultural improvements and transformations through creation of goods, products, and services that impact others, often creating artifacts that have enduring influence (Moran, 2010). Individual benefits make it easy to validate creativity’s importance; however, it is its economic influence that has triggered the influence of creativity, not as something new, but as newly relevant (Craft, 2008; Moran, 2010; Soulé & Warrick, 2015). Creativity is behind the innovation and advances of every great era in human history (Feldman et al., 1994), and it is considered one of the most vital resources a country can develop, essential to entrepreneurial activity, commercial success, competitiveness, productivity, and job satisfaction (Craft, 2008; Florida, 2006; Guilford, 1950; Shane & Nicolaou, 2015; Walton, 2003). Its association with economic benefit is perhaps the element that has made creativity and innovation one of the most studied topics of this century (Pisanu & Menapace, 2014).

The emphasis on the study of creativity at the turn of the century was, of course, not random. The advances in technology at the turn of the century influenced nearly all fields and professions as it connected the world in instant and previously unforeseen ways. The changes enabled access to information and one another, connected ideas and innovation, and triggered cross-cultural and cross-country comparison and competition. The changes at the turn of the
century also created an awareness of the global issues facing and at times caused by humanity (Schwab, 2016). The rate of continuing change brought about by this new era of industry, thought, and connectivity has shifted the demands of the work force, eliminating jobs and entire systems of product manufacturing (Zhao, 2012). This, of course, has also had its impact on the educational system. Increasing calls are made for students to leave the educational system with a variety of skillsets labeled non-cognitive skills, soft skills, or 21st century skills (Moran, 2010; OECD, 2019; Schwab, 2016; Soulé & Warrick, 2015; World Economic Forum, 2016; Zhao, 2018a). Always included in these skill sets as a central feature is creativity. Soulé and Warrick (2015) note this central tendency, stating, “The creativity, innovation, and adaptability that are the hallmarks of competitive, high-growth, and emerging industries require a highly skilled, creative, and nimble workforce” (p. 180).

In addition to the economic drive, creativity creates arguments for its inclusion through its personal impacts and benefits. It impacts essential personal features and skills such as engagement and self-regulation, as previously noted (Moran, 2010). Training in creativity methods such as divergent thinking improves problem finding and problem solving abilities (Acar & Runco, 2012). There is a modest but significant relationship between academic achievement and creativity (Gajda, Karwowski, & Beghetto, 2017). And while also associated with the economy, creativity and innovation are positively related to entrepreneurial mindsets and activities (Pisanu & Menapace, 2014; Shane & Nicolaou, 2015).

The call for an emphasis on creativity and training in its features is not isolated to one country. It, like the many other shifts and innovations of this century, is global. With this global emphasis comes a global demand for the study of effective methods for supporting creativity in education, policies requiring its support and implementation, and programs attempting to foster
creativity in education settings (Craft, 2008). However, even with the global demand to foster creativity in students and in the workforce, much of the research and practice surrounding creativity in education has been misguided or misdirected. This has resulted in studies with a wide range of effect sizes from positive to negative and meta-analyses with small or at best modest effect sizes (Gajda et al., 2017; Karwowski & Lebuda, 2016).

One of the main issues with creativity research and its education implementations is the variance and instability across accepted definitions (Craft, 2008; Moran, 2010; Trotman, 2008). This causes issues not only for meta-analyses but also in the transfer from research into practice and development of policy. Therefore, what is first needed to effectively foster creativity in education is an understanding of creativity definitions, how they differ, and how they complement each other. From this foundational understanding, definitions that can be supported for creativity in education can be highlighted and gaps in understanding for how creativity in education is defined and applied can be identified.

Additionally, scholars tend to segment research on creativity into isolated pieces to analyze discrete elements. When analyzed separately, however, it creates a piecemeal understanding that lacks recognition of the multifaceted nature of individuals in a given context (Craft, 2008; Moran, 2010; Walton, 2003). Instead learner variability must be taken into account when analyzing and implementing creativity in education, and learner variability must be understood as a complex and interactionist feature of educational programs and treatments.

Learner variability is increasingly recognized as relevant for personalized learning and meeting of standards across academic domains. Variability in creativity, though, has not benefited from the same level of research in education, nor has academic research consistently taken into account non-cognitive domains such as creativity in an integrated manner. However,
it is widely accepted that individuals are complex integrations of cognitive, emotional, motivational, biological, and environmental factors that influence when and how one might benefit from a treatment (Rose, 2016; Zhao, 2012, 2018a).

This chapter summarizes the many definitions of creativity and how they have been and should be applied to education. It then explores learner variability in conjunction with creativity in education. Aptitude Theory is explained as a suitable lens for understanding creativity variability, including the complex webs of factors that interact on a personal and individual basis within a given treatment to influence diverse outcomes. Finally, the integration of influencing variables in a situation-specific context is presented as a means for exploring the variability of types of creativity of this study.

The Many Definitions of Creativity

Defining creativity can be an elusive undertaking and depends entirely on the context in which it is defined. It is often paired alongside or used to define such terms as innovation and entrepreneurship (Gomez, 2007; Pisanu & Menapace, 2014; Walton, 2003). It is associated with problem solving and critical thinking. With products and objects and sometimes individuals, it is the trait that separates a creation as unique, novel, expert, or excellent in a specific field or domain (Gomez, 2007). Creativity within a person is often seen as a characteristic, an essential part of human nature. Creativity is associated with traits that support its development such as divergent thinking, openness to ideas and experiences, and flexibility (Acar & Runco, 2012; Barron, 1988; Gomez, 2007; Walton, 2003). None of these definitions are inherently wrong. Rather, they evidence the many ways in which creativity can manifest itself. However, the preponderance of definitions can lead to confusion when trying to build and support educational programs and policies that support creativity. The following sections make clear the more
enduring and accepted definitions of creativity. It then highlights how these definitions are often complementary, and which definitions may be most useful for the different contexts in which creativity and its associated skills are to be developed within education.

**The Creative Product, Process, Person, and Situation**

Among the more pervasive definitions of creativity are those that define facets of creativity, those that explore different levels of creativity, and those that separate creativity amongst domains. The facets of creativity typically include the creative product, the creative process, the creative person, and the creative situation (Cropley, 2001; MacKinnon, 2017; Moran, 2010). Exploration of facets of creativity can be studied at the individual level or understood at an interaction level. At an individual level, each facet is explored separately; researchers explore the creative person, seeking to understand the personality traits associated with creative individuals (e.g. (Grohman et al., 2017; Jonason et al., 2017; Lebuda et al., 2019). Alternately, research may investigate the creative product, utilizing, for example, standards of creativity defined by perceived experts in the relevant field to deem an object creative (Fürst & Grin, 2018). However, as creativity does not happen in a vacuum, when these facets are researched in isolation, they do not offer a full picture of creativity. Recognizing this, efforts have been made to combine some of these facets, exploring the creative person as he or she interacts in a creative process or exploring a creative product through the lens of a creative situation. Such an interactionist approach is suitable for creativity in education as the educational environment (the creative process and situation) undoubtedly impacts the creative person (the learners) and any creative products that are explored and made (Isaksen et al., 1993; Plucker & Beghetto, 2004).

**Big C, little c, Pro-C, and mini-c**
Creativity is also defined by levels or degrees of creativity. The most common distinction between levels of creativity are “Big C” and “little c” creativity. “Big C” creativity deals with creative people or products that impact whole cultures or ages. The actions associated with “Big C” creativity have universal or historic influence. “Little c” creativity, in contrast, is very personal. It can be applied to any situation or context, from problem solving to hobbies, and therefore involves any use of ingenuity. It may still remain unique, but its value is perceived by the relative few (Feldman et al., 1994; Fürst & Grin, 2018; Moran, 2010). Between “Big-C” and “little c,” “pro-c” can be added. “Pro-c” separates the everyday creativity that occurs through “little c” creativity from the professional creativity required of certain industries, positions, or fields of study (Jauk & Sordia, 2018; Kaufman & Beghetto, 2009). Further separation adds “mini-c” for those simple combinations of basic information (Dai, 2020b; Kaufman & Beghetto, 2009). When viewed together, these delineations of creativity can offer different access points into creativity at a variety of developmental stages. Embracing “mini-c,” for example, recognizes the creative potential of young learners who offer unique perspectives into science or math without the professional knowledge of a scientist (pro-c) or the statistical genius of a notable mathematician (Big-C). Likewise, the specialized creativity found in “pro-c” can offer insight into creativity development for older students pursuing specific careers. These delineations offer education systems a lens to view creativity not as a fixed trait students either have or do not have but as a continuous spectrum of creative potential (Dai, 2020b).

**Domain-specific Creativity**

Domain-general creativity includes traits associated with “little-c” creativity and sometimes “mini-c” creativity. In this definition of creativity, it is associated with creativity that has value regardless of field of study or application. For instance, creative problem solving and
creative thinking are both supported by the skill of divergent thinking. Divergent thinking is a domain-general creative ability associated with creative potential and creative processes. It is marked by the ability to come up with novel ideas, elaborate on possible solutions, to think outside the box (Fürst & Grin, 2018; Gomez, 2007). Therefore, regardless of the subject area or profession, divergent thinking, amongst other traits and abilities, is valued as a domain-general creative ability.

Creativity can also be domain-specific, found in differing levels and abilities across fields and practices, jobs and industries (Fürst & Grin, 2018; Plucker & Beghetto, 2004). Domain-specific creativity recognizes the different fields in which people may show specific types of creativity. Often domains of creativity manifest themselves through a combination of personal motivations (e.g. interest in the field), natural abilities and talents, personality and character traits, and an environment that fosters continued growth in a particular domain. How these creativity domains have been separated range from broad and inclusive to delineated by increasingly specific sub-domains and divisions.

In broad terms, creativity can be divided into two or more domains. In one dual domain definition, investigative creativity involves interactions that are more impersonal, objective and precise while artistic creativity is marked as being more emotive, subjective and imprecise (Cropley, 2001). A trio of domains have found evidence for separation into creativity in empathy and communication, math and science creativity, and hands-on creativity (Kaufman & Baer, 2005). Within these divisions, professions and creative individuals tend to be associated with certain fields based on which domain of creativity they most closely relate. For instance, scientists may associate with investigative creativity while painters are more likely to be aligned with artistic creativity. However, even within these broad categories, there are overlaps.
Research on investigative and artistic creativity indicate that individuals could be artistically creative in a field typically associated with investigative creativity, such as mathematics. Similarly, individuals could be more or less creative in either domain across fields (Cropley, 2001). In this manner, creativity is both domain specific and domain general, or as others have confirmed, creativity is at least partially discipline-specific, while other characteristics and traits associated with creativity branch across disciplines (Julmi & Scherm, 2016; Marquis & Vajoczki, 2012).

Creativity domains have also been defined according to the traits and experiences that allow a person to thrive and become a highly effective and creative person. The Institute of Personality Assessment and Research developed this division of creativity into three domains or types: artistic creativity, scientific and technological creativity, and hybrid creativity. The domains focus on a sense of purpose as either fulfilling deeply personal needs, environmental needs without tapping into the creator’s personal interests, or a mix of both personal influence and response to environmental problems (Gomez, 2007; MacKinnon, 2017). While diverse in their manifestations and inner purpose, those high in any of these domains all shared some domain-general creativity traits, including intellectual curiosity and an emphasis on self-discipline, individualism, and the ability to embrace the unconventional. In contrast, those not deemed as highly effective and creative individuals were characterized by low self-esteem and insecurities, intolerant of novel situations, preferring instead the familiarity of conformity, and a fear of disapproval (MacKinnon, 2017).

Domains can also be defined by the underlying skills, attitudes, processes and unique attributes of creativity within a subject or field. Creativity domains have been as nuanced as to include distinctions amongst fiction writing, acting, poetry, visual arts, dance, computer science,
engineering, mathematics, physical sciences, psychology, teaching, leadership, business, management, and even emotional creativity. All these domain categories have overlap and carry potential implications for education institutions on methods for supporting domain-general creativity; they also all carry unique, domain-specific creativity characteristics that require unique opportunities for development (Kaufman & Baer, 2005).

**Creativity in Education**

The traditional applications of creativity in education have not made use of the full scope of these definitions. Rather, creativity in education tends to refer to elective areas such as music class or art (Hui et al., 2015; Moran, 2010). Alternately, it is implemented in gifted and talented programs, limiting the population that has access to integrated, creative endeavors (Chan & Yuen, 2014; Ferrari et al., 2009; Makel, 2009; Moran, 2010). However, the definitions and views of creativity highlighted above provide distinct applications for an expanded understanding of creativity in education that provides the equitable access needed to fulfill today’s societal and cultural demands for creativity.

In education, the perspective of domain-general creativity is useful as it can be applied across subject areas and lessons. The traits of creative problem solving and creative critical thinking can be fostered regardless of subject area. However, only focusing on domain-general creativity limits creativity in education. It does not allow for the many avenues in which individuals can be creative, which does not support the increased call for personalized learning and individual talent development (Lamprini & Bröchler, 2018). For personalization to be supported, creativity in education must also incorporate domain-specific creativity support. As students show interest in professional tracks or talent in specific areas, creativity programs in education can provide domain-specific creativity support. However, domain-specific creativity in
education is, as noted, lacking, and as such learner variability as it applied to creativity must be explored and researched to foster personalized creative growth.

**Creativity and Learner Variability**

Learners vary significantly in classrooms. Within any classroom, a teacher will have a range of mathematical abilities, reading abilities, critical thinking abilities and more. The spectrum of cognitive learner variability has been well-established. It is influenced by background characteristics such as socio-economic status, race, culture, and gender; personal factors such as interests, abilities, emotions, and personality factors; and environment factors that can either foster or inhibit growth in any given subject or content area (Glass et al., 2013; Immordino-Yang, 2015; Meyer et al., 2014; Pape, 2018; Quaglia, 2015; Rose, 2016; Siegler, 2007; Tare et al., 2018). Learner variability has always existed, but the increasingly diverse web of individual factors influenced by globalization, connectivity, and today’s multicultural societies makes its current study imperative (Scarino, 2014).

In the classroom, variability exists in more than just academic domains. It is “omnipresent, occurring at all ages, in all [emphasis added] domains, and at all points in learning” (Siegler, 2007, p. 104). In the same way there exists infinite combinations for learner variability in reading, math, science or other subject areas, learner variability exists across creative abilities. Individuals can be more or less creative over time (for instance moving from “mini-c” to “little c” to “pro-c” and “Big C”), or they may be more or less creative depending on the domain (e.g., being more creative in logic-oriented endeavors than in artistic endeavors). In order to explore the variables that contribute to or inhibit creative growth in educational programs, an integrated lens is needed. Aptitude Theory provides such a way of analyzing those
variables most significant to a given treatment or program in the context of the specific environment in which the treatment takes place.

**Aptitude Theory**

Aptitude Theory (AT) was popularized in the 1970’s and early 1980’s, and although it was actively pursued into the next decade, it did not gain the traction needed to be pushed to the forefront in education research. Rather, theories and methodologies that catered to standardization and rigorous interventions won the focus (Snow, 1992). However, this century’s changes and increased understanding of learner variability bring renewed relevance to the exploration of aptitude theory, human potential, and, in turn, aptitude-treatment interaction (Dai, 2020a). Aptitude theory provides an integrative solution to explore individuals’ creativity domains, talents, interests, and variable potential as they interact with a creative environment.

Aptitude theory is centered on a complex person-situation interactional paradigm. Importantly, it reverts back to former, more encompassing definitions of aptitudes that go beyond today’s common association of aptitude with academic ability. Rather, aptitudes are initial states of the mind, including cognitive, conative, and affective traits (Dai, 2020b; Dörnyei & Schmidt, 2001; Gardner, 2020; Kupermintz, 2002; Martinez, 2014; Snow, 1991, 1992; Snow, 1997; Snow et al., 1996). While it is largely recognized that this triad exists in a synergistic harmony within individuals, the three components are often separated for research and study, with a predominant focus on the cognitive aspect alone (Gustafsson & Undheim, 1996; Kupermintz, 2002; Snow et al., 1996). However, these traits become almost arbitrary and meaningless when studied independently as they are interrelated and dynamic. To separate them is to lose understanding of the holistic explanations involved in the learning and development processes (Dörnyei & Schmidt, 2001). Additionally, even where cognitive-focus studies
separate out the other two elements of this triad, there is consistent acknowledgement of the influence and interaction of affective and conative traits on cognitive functioning (Snow et al., 1996).

**Cognitive Aptitudes**

Cognitive traits include those traditionally academic characteristics of learning and knowing: the receipt of information, encoding the data, processing it on various levels and retrieving it for later use, abstract reasoning, problem solving, and decision making (Gustafsson & Undheim, 1996; Snow et al., 1996). Cognition and cognitive abilities have then become largely associated with academic aptitudes, including general methods for acquiring and retaining knowledge such as learning to read, factual recall, and application of standard analytical functions. It also includes domain-specific abilities such as giftedness or predilection toward mathematics, a field of science, or the ability to comprehend text. English & English (1958, p. 92) define cognition as the following:

> Cognition – a generic term for any process whereby an organism becomes aware or obtains knowledge of an object…It includes *perceiving, recognizing, conceiving, judging, reasoning*...[I]n modern usage sensing is usually included under cognition (as cited in Snow et al., 1996, p. 243)

Schooling in recent decades has chosen to focus on this layer through accountability measures, assessments, and standardization, prompting many research investigations to also focus on cognitive aptitudes in isolation (Feldman, 2020).

**Conative and Affective Aptitudes**

Human learners, though, are far more complex than what cognitive traits alone can elucidate. Conative and Affective domains are at times separated for their own studies, and they
are frequently lumped together in the so-called “non-cognitive traits” or “soft skills” (Gardner, 2020). These traits have seen some attention in recent years as industry and economies have increased their demand for non-cognitive traits or transversal skills (Čepić et al., 2015; Chu et al., 2017; Cotet et al., 2017; Kim, 2016; Lamprini & Bröchler, 2018; Manu, 2016; Van Dam, 2017; World Economic Forum, 2018). Conative traits factor in actions which are purposeful and deliberate. Conation refers most often to motivation and volition, concerning values, incentives, and likelihood to succeed and what will facilitate or hinder performance or the ability to maintain pursuit toward a goal (Kupermintz, 2002). The self-directed learner and the self-regulated learner and the traits that motivate such an individual, such as self-control and perseverance, are tied to conation (Huitl & Cain, 2005; Snow et al., 1996) and can be defined as follows:

**Conation** – That aspect of mental process or behavior by which it tends to develop into something else; an intrinsic “unrest” of the organism…almost the opposite of **homeostasis**. A conscious tendency to act; a conscious striving…It is now seldom used as a specific form of behavior, rather for an aspect found in all. Impulse, desire, volition, purposive striving all emphasize the conative aspect. (English & English, 1958, p. 104 as cited in Snow et al., 1996, p. 244)

Often linked together with conation is affection. In addition to also being labeled “noncognitive,” affection is closely associated with dispositions (Dai, 2020b). It includes feelings, reactions, likes, and dislikes. It is aligned with emotions and moods and personality traits (Gardner, 2020; Kupermintz, 2002; Snow, 1997; Snow et al., 1996). Following the line of definitions, affection is as follows:

**Affection** – A class name for feeling, emotion, mood, temperament… a single feeling-response to a particular object or idea…the general reaction toward something liked or
disliked…the dynamic or essential quality of an emotion; the energy of an emotion

(English & English, 1958, p. 15 as cited in Snow et al., 1996, . 243-244)

**Integrating Aptitude Complexes in Research**

When these three fields are researched exclusive of each other, critical connections can be missed. Understanding why results occur in certain patterns or ways requires an expansive and simultaneously integrated view of the variables within all three aptitude complexes (Snow, 1992). Additionally, the danger of *not* addressing all three aspects of the mind can lead to adoption of programs or continuance of programs that actually do harm to some individuals (Snow, 1997; Snow et al., 1996; Zhao, 2018b).

This can obviously be problematic for researchers; there are seemingly innumerable combinations of characteristics, experiences, preferences, traits, etc. within individual students. Gardner (2020) cites this dynamic variability, noting “humans differ from one another at least as much as do snowflakes or bacteria, and we need to survey that *entire* canvas [emphasis added] in any account of human potential” (p. 16). Such uniqueness is evidenced in an individual’s jagged profile – that is, their own unique profile of strengths, weaknesses, interests, background experiences, moderating preferences, innate abilities, etc. (Dai, 2020b; Moran, 2020; Rose, 2016; Zhao, 2018a). Moreover, in addition to the web of potential aptitudes within any given individual, these complex systems are exponentially available within a classroom or program full of students. On top of this, there are additional environmental variables that influence learning outcomes. Environmental variables could include the influence of individual teachers or the type of teaching structure (e.g. highly structured versus student-initiated or open exploration) (Snow, 1997).

**Creativity Domains through an Integrated, Multivariate Lens**
The demand for creativity in education is universal; however, the multiplicity of definitions and narrow scope of application have made it difficult to implement in consistently effective manners. This chapter sought to clarify the most common definitions and interpretations of creativity and identify those most useful for creativity in education. Additionally, it identified the importance of learner variability but noted the missing application of creativity variability. Aptitude Theory is presented as a method for exploring how creativity domains can vary within educational contexts.

In a system that seeks to educate all, the variety of individual jagged profiles can be daunting and overwhelming to both researchers and practitioners. “Human diversity is ubiquitous in education, and this poses both problems and possibilities” (Snow et al., 1996, p. 244) (see also Snow, 1992). The sheer abundance of aptitudes available amongst cognitive and noncognitive variables combined with interacting treatment variables is problematic; however, these unique profiles do have a tendency to form clusters and patterns (Celik & Yavuz, 2020). Therefore, to better understand the role of learner variability in creativity education, exploration is needed of the patterns that can be found in groups and subgroups within specific treatments.

Through the expanded definition of aptitudes in a context-driven perspective, an exploration would ideally address both cognitive and noncognitive variables as well as context variables most relevant to the researched treatment. This includes cognitive and noncognitive components that would impact readiness to learn and ability to be challenged within the treatment (i.e., learner thresholds and zone of proximal development – ZPD) (Dai, 2020b; Gustafsson & Undheim, 1996; Snow, 1992; Snow, 1997). In the present study, these interacting variables are explored in the context of a specific treatment intended to foster creativity. The trends made visible and theorized influencing interactions provide a model for understanding
what groups and subgroups do or do not benefit from a given education treatment program that intends to foster creativity.
Chapter 3 Methods

This chapter first presents the context of the exploratory study by defining relevant treatment details and those who participated in it. It then outlines the assessments and measures conducted during the treatment, including collection of demographic variables such as age, race, gender, and country of origin. These variables are explored in conjunction with factors of the treatment program to understand any overarching treatment outcomes and creativity varies within this treatment by type and across and subgroups.

Treatment

The treatment in this study consisted of participation in a two-week long program focused on innovation, creativity, and entrepreneurship (hereafter referred to as treatment). The treatment was held on a secondary campus in Chongqing, China in August of 2019. The treatment was intended to be an immersive experience exploring the main topics and objectives of innovation, creativity, and entrepreneurial processes and mindsets. The camp was taught in English, and as such English language development was a secondary potential outcome of the treatment. Participants were divided into eight groups with one master teacher to serve as mentor, recruited from international schools utilizing programs that emphasized the treatment’s targeted objectives. Two teaching assistants from local area colleges were also assigned to each group to serve as bilingual mentors where and when appropriate for the learning environment. Bilingual mentors did not, however, create a bilingual education experience. Rather, they facilitated main instructions, responded to student needs, and were utilized to ensure safety and wellbeing. Participants in each of the eight groups were guided through activities that supported the treatment’s main goals. It specifically followed a defined entrepreneurship process to authentically solve a given problem. Groups created products in response to a design brief.
illustrating a local community-based problem. They worked in a collaborative environment utilizing resources of peers, teachers and mentors, and local outings chosen to enhance understanding of the problem’s context. Within this environment, participants were encouraged to take ownership of designing solutions and products, exploring and utilizing individual talents and strengths, and developing collaborative communities and networks within and outside of their assigned groups. To facilitate awareness of strengths and talents, participants completed questionnaire identifying their dominant domain of creativity. Results were used to analyze how their unique talents and strengths might contribute to group needs and group products. Additional assessments were utilized by the implementing organization for parent and student information reports and internal company analysis for growth and improvement.

Participants

The treatment program included participants entering 7th grade at a local secondary school in Chongqing, China (total Chinese treatment program participants = 166), as well as participants across secondary level schools from Australia (N = 21), England (N = 4), and the United States (N = 9) (total international treatment program participants, combined = 35). The treatment program included 75 female (59 Chinese, 16 international) and 126 male (107 Chinese, 19 international) participants. Students were divided amongst eight groups with the aforementioned international teacher and two bilingual mentors. Two additional teachers and program staff served as floating personnel to assist where and when needed. Each group had an even distribution of 4-5 international participants with the remainder of each group represented by Chinese participants.

Influencing Variables, Instruments and Data Collection
The variables presented here were selected represent those most relevant to exploring how types of creativity was variable for the treatment participants. The dominant variable explored was creativity. This was explored through the Kaufman Domains of Creativity Scale (K-DOCS). Additional cognitive variables were also explored as relevant to this particular creativity program. Finally, other influencing variables were identified for exploration in the present study.

**Kaufman Domains of Creativity Scale (K-DOCS)**

Beginning, in the early 2000’s a series of creativity questionnaires were developed to identify potential domains for domain-specific creativity. Types of the first developed was the Creative Domain Questionnaire (CDQ) and the Revised Creative Domain Questionnaire (CDQ-R) (Kaufman, 2006, 2012; Kaufman et al., 2009; Kaufman et al., 2010; Silvia et al., 2012). These found a range of domains, including artistic-verbal, artistic-visual, entrepreneur, interpersonal, math/science, performance, and problem solving (Julmi & Scherm, 2016; Kaufman et al., 2009). Further research prompted the development of the Kaufman Domains for Creativity Scale (K-DOCS), specifically designed to focus on the domain-specific perspective rather than general creativity perspective. Questions from previous versions of the CDQ were adapted to create a 94-item questionnaire given to 2,318 participants alongside a five-factor personality questionnaire. Through principal and secondary factor analysis, the 94 items were reduced to 50 items that loaded strongly across five domains. The domains of creativity identified from the K-DOCS factor analysis are Self/Everyday creativity (S/E), Scholarly creativity (SCH), Performance creativity (PERF), Mechanical/Scientific creativity (M/SCI), and Artistic creativity (ART) (Kaufman, 2012).
When taking the K-DOCS (Kaufman, 2012; McKay et al., 2017) participants receive scores in each of the five domains of creativity. For each domain, participants respond to a number of items asking to rate how creative they were compared to peers of their own approximate age and life experience. They could respond on a scale of 1-5 from “much less creative” to “much more creative.” The construct for Self/Everyday creativity consists of 11 items (α = .86) measuring interpersonal and intrapersonal creativity across everyday activities. The construct for the Scholarly domain consists of 10 items (α = .86) measuring creativity in scholarly and research-centric pursuits. The construct of Performance creativity is assessed by 10 items (α = .87), measuring creativity in performance driven writing, music, and acting. The construct of Mechanical/Scientific creativity includes 10 items (α = .86) measuring mechanical, scientific, and mathematical creative abilities. Finally, the construct of Artistic creativity is measured by 9 items (α = .83) and includes creativity normally associated with visual arts such as photography, painting, and pottery. The overall reliability of the K-DOCS instrument (Cronbach’s alpha) is 0.8, indicating internal consistency and reliability for each of the five domains (Kaufman, 2012). Subsequent replication of the study measured reliability again as well as validity of the instrument. Convergent and discriminant validity of the five domains of the K-DOCS instruments were found across domain-general and domain-specific predictors of creativity, while factor analysis again found the five-domain structure reliable (for full analysis see McKay et al., 2017).

Pursuant to IRB approval, participants completed the K-DOCS instrument on the first and final day of the treatment. Averages within each domain were calculated for each participant with the highest domain reported to participants. Change scores were also calculated to determine change at end of the treatment from the beginning of the treatment. Additionally, age,
gender, and education background (separated by Eastern and Western cultural influences) were collected as demographic questions added to the K-DOCS instrument. Means and standard deviations (SD) are provided for whole treatment analysis across the five domains as well as change scores. Descriptive statistics are included for the demographic information.

Each domain identified by the K-DOCS carries domain-specific markers of creativity. Self/Everyday creativity is exemplified by questions relating to interpersonal and intrapersonal creativity. These include items such as “understanding how to make myself happy” and “getting people to feel relaxed and at ease.” Scholarly creativity is characterized by analysis, debate, and scholarly suits. It includes items such as “debating a controversial topic from my own perspective” and “writing a letter to the editor.” The third domain, performance, includes written and musical options for performance with such items as “playing music in public” and “making up rhymes.” While writing, music, and acting all feature within these questions, Kaufman (2012) notes they generally focus on public performance within the associated questions. Mechanical/scientific creativity focuses on interest in science and math as well as general mechanical abilities, including “solving math puzzles,” “building something mechanical (like a robot),” and “helping to carry out or design a scientific experiment.” Finally, artistic creativity, the fifth domain, separates itself from the performance domain by focusing on the physical creations traditionally associated with the arts. Items include “making a sculpture or piece of pottery” and “sketching a person or object” (Kaufman, 2012).

These traits and associated activities give insight into the types of behaviors and personalities that embody a creative person across each domain. These distinctions can be very useful for identifying how a person might be creative and personalizing individual learning tracks. As creativity is deeply personal (Tsankov, 2017), and associated with certain
characteristics and personality traits (Feist, 2010; Kaufman, 2012; Lee, 2017), utilizing domains of creativity in the present study incorporated elements of emotion and motivation to account for Aptitude Theory’s non-cognitive factors. Treatment participants received results of their individual K-DOCS in the form of their dominant domain of creativity. This was intended within the treatment to prompt thinking of individual interests and talents and how they could be applied within the learning environment. Therefore, each creativity domain was treated as a grouping aptitude or variable.

Assessment of English Language Abilities

As the treatment in the present study used English as a secondary goal and conduit for learning, the most relevant cognitive factor that could facilitate or inhibit a participant’s ability to interact and benefit from the treatment was English language ability. Learning and instructional times were taught in an English immersive environment; however, eastern education participants had little English language experience and therefore may not have had the same level of interaction or benefit from the treatment as those whose native language was English. Therefore, English language ability is a variable suitable for understanding the influence of a cognitive trait while also recognizing it as a treatment variable (i.e. the language of instruction). Whether or not individuals were able to benefit from the treatment and its creativity goals may have been at least partially dependent on their ability to interact with the treatment language. It should be noted, this does not automatically indicate that English as a language fosters or inhibits creativity on its own. Rather, in this particular context, it was an influential variable for exploration.

Chinese participants completed oral, written, and vocabulary assessments of English language proficiency at the start and end (day 12 of 14) of the treatment for the purpose of learner progress reports. Oral assessment included a prompt asking participants to provide a 1-2-
minute response to a given question. Written responses, similarly, provided students with a prompt, allowing five minutes to respond to a given topic. Both written and oral assessments were scored by treatment staff based on an adapted English for Speakers of Other Languages (ESOL) rubric with scores ranging from 0-3. Vocabulary assessments were given by asking students to define 5 randomly selected high frequency words (from Fry’s 1000 high frequency words, https://www.k12reader.com/Fry-word-list-1000-high-frequency-words/). Upon accurate definition of the first five randomly selected words, the next 5 randomly selected words were given. This process was repeated as many times as needed during vocabulary assessment. Correct responses were then scaled to levels on a 0-3-point scale. Scores for each language assessment were approved for inclusion as existing data and provided for use as relevant cognitive aptitudes, given the treatment was conducted in English. All three assessment scores were averaged for an overall English language ability at beginning and end of treatment. For international students whose first language was English, a standard score of 4 was designated to represent native fluency. Means and standard deviations were calculated for this overall average both with and without international participants.

Additional Interacting Variables

Creativity and learner variability are also greatly influenced by cultural perceptions, acceptance, and understandings (King & McInerney, 2014; Ng, 2001, 2003). The eastern traditions, as represented by the majority of the treatment participants, are largely built on Confucian societies and thus the individual, and in turn individual creativity, are not esteemed on par with the collective, wider group. In contrast, the cultural influence of western education systems – as represented by the international participants – place higher value on individualism and pursuit of individual interests and passions. Rather than validation coming from the group,
validation is often perceived through differentiation and difference. In the eastern traditions, creativity has traditionally been developed through personal and inner development – a spiritual expression; the western traditions have valued creativity more directly through product creation (Craft, 2008; Ng, 2003). These contrasts have meant, historically, those associated with the eastern traditions are seen as less creative by western definitions of creativity, including those definitions explored here. Additionally, it means those of western tradition may have been more primed to benefit from the treatment program and its emphasis on individual strengths and talents and creativity profiles. However, the emphasis and value placed on collectivism could also have been advantageous to those of eastern cultural influence as it is associated with an interdependent construal of the self, whereas western traditions tend to develop an independent construal of the self (Ng, 2003). In this light, those of the eastern tradition may have had an advantage in understanding the value of others’ strengths and abilities and the need to create collaboratively based on collective and complementary traits. In both interpretations, the influences of culture (applied here as eastern education or western education orientations) and the creativity aptitudes it could shape were explored within the present study.

An additional variable for exploration is gender. Both creativity research and research on the intersectionality of aptitudes and learner variability often investigate the influential role of gender (Baer & Kaufman, 2008; Batey & Furnham, 2006; Celik & Yavuz, 2020; Furnham & Bachtiar, 2008; Gralewski & Karwowsk, 2013; Kaufman, 2006; Pape, 2018; Rouxel, 2000; Shavelson et al., 2002). While not strictly an aptitude in the same sense of the cognitive and noncognitive traits highlighted elsewhere, gender has been researched in terms of stereotypes and stereotype threat (e.g. STEM domains of creativity being male dominant or traditional creativity as found in the arts as female dominant) (Kaufman, 2006) as well as how creative a
participant is perceived within education environments (Gralewski & Karwowski, 2013). Additionally, gender differences have been found in personality, interests, and motivation (Ackerman et al., 2001) which have been identified as the traits, characteristics, and variables directly related to affective and conative aptitudes.

The instruments noted in this main section had the purpose within the treatment of facilitating interactions, monitoring progress toward treatment objectives, and developing preliminary jagged profiles for students to understand their own unique talents and strengths. As applied to this exploratory study, the instruments are used to understand how types of creativity vary and how creativity changes before and after the treatment. The variables highlighted above were selected from the available data as most propaedeutic to success in the treatment program. In other words, they are most relevant for exploring outcomes that potentially impacted participants and most influential for formation of groups and subgroups. These were explored in context of a specific treatment intended to facilitate the expression of unique creative talents and abilities. This exploration seeks to understand how a given treatment interacts with types of creativity and other influencing variables to accomplish or suppress growth in and association with creativity.

Analysis

Data Preparation

All K-DOCS responses from beginning (N = 236) and end of treatment (N = 162) were reviewed for completion. Responses with more than 1 item missing for any given domain were excluded (beginning of treatment = 30; end of treatment = 0). From these two sets of responses, responses for beginning and end of treatment were matched by individual and anonymized. Responses that did not have a beginning or end of treatment paired response were removed from
the data set. In line with the instrument’s previous definition of patterned responders (McKay et al., 2017), responses that selected the same scale point for 40 or more of the 50 items were also removed. This resulted in 135 valid, paired responses for exploratory analysis (Chinese participants = 120; International participants = 15).

**Research Questions**

In order to gain a high level understanding of creative variability (RQ1), descriptive statistics were calculated (i.e., mean, standard deviation, upper and lower confidence intervals, and percentages, as applicable) for the participants of the treatment program as a whole. To address the patterns of distribution for education orientation, gender, English language ability, and potential treatment interactions (RQ 1a – 1b), the following variables were included and analyzed: age, gender, race/ethnicity, and English language abilities and creativity domain averages and associations at beginning and end of treatment. Successively, groups were determined by initial dominant creativity domain and related creativity profiles were given (means for each creativity domain for that dominant domain group) to determine the patterns of association within creativity for groups and subgroups.

Understanding change that occurred after the treatment required a layered analysis (RQ 2: How malleable are types of creativity in this treatment with Chinese and non-Chinese adolescents?). First, change in association with a particular creativity domain was assessed. A cross-tabulation (see Table 6) was performed along with a visual migration chart (Figure 1) to understand if and how individuals persisted or changed across creativity domains (RQ 2a). These new groups – both those that stayed within the same domain and those that changed domains – were then explored for understanding how groups and subgroups, as formed by education orientation, gender, and English language ability, changed after the treatment (RQ 2b –
2d). Exploration of these groups and subgroups was first analyzed through mean change differences and successively through sub-group trend analysis between beginning and end of treatment measures. Within these groups and subgroups, analysis of potential influences of the treatment itself was explored (RQ 2e).

Additionally, a critical understanding of how change occurs in creativity concerned those who saw diminished association with multiple creativity domains. Thus, regardless of the focus of all sub-questions under Research Question 2, groups and subgroups who saw negative change at the end of the treatment were analyzed separately. These participants represented who the treatment may not have worked for. Demographics for this group were factored into analysis, including gender, English language ability, education orientation, and dominant creativity domains. This group was also analyzed by mean change and trend analysis to investigate patterns in change after the treatment.

RQ1: How variable are types of creativity in this treatment with Chinese and non-Chinese adolescents?

a. What patterns in distribution across dominant domains of creativity are evident for education orientation at the beginning and end of treatment amongst the treatment participants?

b. What patterns in distribution across dominant domains of creativity are evident for gender at the beginning and end of treatment amongst treatment participants?

c. What patterns in distribution across dominant domains of creativity are evident for English language ability at the beginning and end of treatment amongst treatment participants?
d. What patterns in distribution across dominant domains of creativity are potentially attributed to treatment interaction amongst treatment participants?

RQ 2: How malleable are types of creativity in this treatment with Chinese and non-Chinese adolescents?

a. What patterns are evident for change of association with dominant domains of creativity?

b. What patterns in change (positive or negative) in degree of association with dominant and secondary domains of creativity are evident for education orientation from beginning to end of treatment?

c. What patterns in change (positive or negative) in degree of association with dominant and secondary domains of creativity are evident for gender from beginning to end of treatment?

d. What patterns in change (positive or negative) in degree of association with dominant and secondary domains of creativity are evident for English language ability from beginning to end of treatment?

e. What patterns in change (positive or negative) in degree of association with dominant and secondary domains of creativity are potentially attributed to treatment interactions from beginning to end of treatment?
Chapter 4 Findings

This chapter presents the findings of the exploratory analysis through a series of layers. From a high-level view, analysis was completed on distribution of treatment participants across creativity domains as well as overall changes and outcomes of the treatment program that seemed to impact all participants. At the next layer, groups and subgroups were analyzed according to whether they maintained association with a specific creativity domain or whether they changed domains. These groups were defined in such a manner to ensure those analyzed within a given domain were the same members from beginning to end of treatment. A final layer of analysis explored negative trends and outcomes, regardless of creativity domain, to understand potential side effects of the treatment.

Whole Treatment Analysis

After combining and sorting data, there remained a total of 135 valid responses (Total Beginning N = 236; Total End N = 162), including 120 valid Chinese participants and 15 valid international participants (72% valid response rate for Chinese participants; 44% valid response rate for international participants; 68% valid overall response rate for all included responses). The average age of Chinese participants at the start of the treatment program was 11.94 years, average age of international respondents – 14.53, average age of all treatment participants – 12.23 (SD = 1.106). Participants included 84 male participants, representing 62.2% of the sample (76 Chinese, 8 international), and 51 female participants, representing 37.8% of the sample (44 Chinese, 7 international).

Race/Ethnicity was collected as part of the K-DOCS questionnaire. Of the Chinese participants, all were considered Asian. An additional 4 international students were considered Asian, including one White/Asian. In the international population, the remaining distribution
was as follows: 9 White (including the one White/Asian participant), 1 Black or African American, 2 Hispanic/Latino(a)/Spanish origin. While other race/ethnicity options were available to select on the instrument, these populations were not represented within the participant sample. Using race/ethnicity, however, would result in extremely small subgroups, and these would be for international participants only. An alternate view of demographic groups was obtained via cultural and educational influence. From this delineation, 120 respondents came from an eastern (Chinese) education background, while the remaining 15 came from a western education background. Tables 1 and 2 outline these descriptive statistics.

<table>
<thead>
<tr>
<th>Table 1</th>
<th>Age and Gender by Education Background</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Female</td>
</tr>
<tr>
<td>Chinese (Eastern Education Systems)</td>
<td>44</td>
</tr>
<tr>
<td>International (Western Education Systems)</td>
<td>7</td>
</tr>
<tr>
<td>Total</td>
<td>51</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Table 2</th>
<th>Race by Education Background</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Asian</td>
</tr>
<tr>
<td>Chinese (Eastern Education Systems)</td>
<td>120</td>
</tr>
<tr>
<td>International (Western Education Systems)</td>
<td>4*</td>
</tr>
<tr>
<td>Total</td>
<td></td>
</tr>
</tbody>
</table>

*One participant identified as Asian and White; this participant is included in both counts.

Chinese participants also completed the English Language Proficiency assessments on the first and 12th day of camp. These were used initially as a method of equivalent distribution of
abilities across treatment groups and successively to show any growth as part of a report sent home with Chinese participants at the end of the treatment. Scores across domains of oral, written, and vocabulary fluency were rated on a 0-3 scale and averaged for an overall English language proficiency here. As all international participants held native level fluency, their scores were assigned a level 4. Because of the potential significant difference between levels of English as a foreign language and native fluency in English, means and standard deviations were calculated for the full treatment sample as well as the Chinese participants separately (see Table 3).

<table>
<thead>
<tr>
<th>Table 3. English Language Proficiencies</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
</tr>
<tr>
<td>N</td>
</tr>
<tr>
<td>Chinese Participants</td>
</tr>
<tr>
<td>Treatment Participants</td>
</tr>
</tbody>
</table>

The K-DOCS instrument was given at the start and end of the treatment. Scores were calculated across each of the five domains. When taken as a whole treatment average, data would suggest moderate (a score between 3-4) to strong (a score between 4-5) association with the creativity domains and overall an increase in association with each domain across all five domains of creativity (see Table 4).

<table>
<thead>
<tr>
<th>Table 4 Whole Group Creativity Domain Averages</th>
</tr>
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<tbody>
<tr>
<td></td>
</tr>
<tr>
<td>N = 135</td>
</tr>
<tr>
<td>Beg. Mean</td>
</tr>
<tr>
<td>Self/Everyday</td>
</tr>
<tr>
<td>Scholarly</td>
</tr>
<tr>
<td>Performance</td>
</tr>
<tr>
<td>Mechanical/Scientific</td>
</tr>
<tr>
<td>Artistic</td>
</tr>
</tbody>
</table>
On the initial assessment, 50 participants were identified under Self/Everyday creativity; of these, 47 were Chinese participants, 3 were international participants (34 male, 16 female). Nine participants were identified under Scholarly creativity, including 5 Chinese participants and 4 international participants (6 male, 3 female). Nine participants were also identified under Performance creativity again with 5 Chinese participants and 4 international participants (5 male, 4 female). Twenty-five participants were identified under Mechanical/Scientific creativity, of which 24 of the 25 were Chinese participants and 1 international (20 male, 5 female). Finally, 29 participants were identified under Artistic creativity, including 26 Chinese participants and 3 internationals (9 male, 20 female). Note: an additional 13 Chinese participants scored equally on two or more domains. As the current exploratory research seeks to understand domain-specific creativity and interacting variables within specific domains, this sub-group will be reserved for later research and analysis. This reduces the population in creativity domains hereafter to 122. The distribution of participant’s dominant creativity domains, along with initial group means and standard deviations are included in Table 5. Group means for non-dominant creativity domains were also calculated to determine how participants changed both within their dominant domain and within other domains of creativity.

**Understanding Variability in Subgroups**

In order to understand how creativity types varied and how other contributing variables (education orientation, gender, and English language ability) interacted with the treatment to change creative variability, populations were first compared between beginning and end responses on the K-DOCS instrument. In other words, for those dominant in one domain at the start of the treatment, who remained dominant in the same domain at the end of treatment. A
Table 5
Dominant Domains of Creativity at Start of Treatment

<table>
<thead>
<tr>
<th>Dominant Domain:</th>
<th>N</th>
<th>Percentage*</th>
<th>Mean</th>
<th>SD</th>
<th>Lower &amp; Upper Bound</th>
</tr>
</thead>
<tbody>
<tr>
<td>Self/Everyday</td>
<td>50</td>
<td>37.0%</td>
<td>4.40</td>
<td>.47</td>
<td>4.27, 4.54</td>
</tr>
<tr>
<td>Scholarly</td>
<td>3.91</td>
<td>.49</td>
<td>3.77, 4.05</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Performance</td>
<td>3.77</td>
<td>.52</td>
<td>3.62, 3.92</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mechanical/Scientific</td>
<td>3.56</td>
<td>.77</td>
<td>3.34, 3.78</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Artistic</td>
<td>3.84</td>
<td>.64</td>
<td>3.66, 4.03</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Scholarly</td>
<td>9</td>
<td>6.7%</td>
<td>4.21</td>
<td>.55</td>
<td>3.79, 4.64</td>
</tr>
<tr>
<td>Everyday/Self</td>
<td>3.66</td>
<td>.56</td>
<td>3.22, 4.09</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Performance</td>
<td>3.17</td>
<td>.74</td>
<td>2.60, 3.74</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mechanical/Scientific</td>
<td>3.53</td>
<td>.48</td>
<td>3.16, 3.90</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Artistic</td>
<td>3.13</td>
<td>.67</td>
<td>2.61, 3.64</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Performance</td>
<td>9</td>
<td>6.7%</td>
<td>4.37</td>
<td>.29</td>
<td>4.14, 4.59</td>
</tr>
<tr>
<td>Everyday/Self</td>
<td>4.11</td>
<td>.34</td>
<td>3.85, 4.38</td>
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</tr>
<tr>
<td>Scholarly</td>
<td>3.96</td>
<td>.45</td>
<td>3.62, 4.30</td>
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<td></td>
</tr>
<tr>
<td>Mechanical/Scientific</td>
<td>3.65</td>
<td>.51</td>
<td>3.26, 4.05</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Artistic</td>
<td>3.62</td>
<td>1.10</td>
<td>2.77, 4.46</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mechanical/Scientific</td>
<td>25</td>
<td>18.5%</td>
<td>4.60</td>
<td>.34</td>
<td>4.45, 4.73</td>
</tr>
<tr>
<td>Everyday/Self</td>
<td>4.08</td>
<td>.47</td>
<td>3.82, 4.16</td>
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<td></td>
</tr>
<tr>
<td>Scholarly</td>
<td>4.04</td>
<td>.45</td>
<td>3.85, 4.23</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Performance</td>
<td>3.98</td>
<td>.49</td>
<td>3.77, 4.18</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Artistic</td>
<td>3.88</td>
<td>.47</td>
<td>3.68, 4.07</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Artistic</td>
<td>29</td>
<td>21.5%</td>
<td>4.44</td>
<td>.45</td>
<td>4.26, 4.61</td>
</tr>
<tr>
<td>Everyday/Self</td>
<td>3.98</td>
<td>.47</td>
<td>3.80, 4.16</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Scholarly</td>
<td>3.63</td>
<td>.61</td>
<td>3.40, 3.86</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Performance</td>
<td>3.74</td>
<td>.64</td>
<td>3.49, 3.98</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mechanical/Scientific</td>
<td>3.67</td>
<td>.71</td>
<td>3.40, 3.94</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*Percentages determined from full participant sample of 135, including those rated as dominant in more than one domain.

cross-tabulation of distribution (see Table 6) amongst the creativity domains at both time points indicated more changes than anticipated in association with the dominant creativity domains.
To visually explore the data presented in the Table 6, a Sankey analysis (Thanks to Flerlage, K. Sankey Template https://www.flerlagetwins.com/2018/04/sankey-template.html) was developed (Figure 1).

The malleability found in change of association with dominant domains requires further exploration. What were the participant variables for those who remained dominant in the same creativity domain? What was the degree of change for this subgroup? For those who changed domains, what were the relevant participant variables and were there thematic movements amongst the domains? This exploration is represented by analysis in Figures 2-8 and in their corresponding sections.

Holistically, the majority of participants remained dominant in the same domain from beginning to end of treatment with a notable majority in Self/Everyday creativity (N = 84 or 62% of valid responses). Of the thirty-seven participants who changed domains, more than a quarter were also seen moving into Self/Everyday creativity (N = 13; 27% of valid responses). Performance creativity, which saw little association to begin with, also saw great disruption of its remaining members. Therefore, there was limited possible analysis of this domain.

Specific distributions across domains from beginning to end of treatment follow. Of the original 50 members of the Self/Everyday creativity domain, 41 remained dominant in Self/Everyday creativity; three changed dominance to Scholarly creativity, 3 changed dominance to Performance creativity, 2 changed dominance to Mechanical/Scientific creativity, and 1 changed dominance to Artistic creativity. Of the 9 members of the Scholarly domain, 6 remained dominant in Scholarly creativity; 1 changed dominance to Everyday/Self, 1 to Mechanical/Scientific, and 1 to Artistic. There were no changes from Scholarly to Performance creativity. Of the 9 members of the Performance domain, 4 remained dominant in Performance
creativity; 2 changed dominance to Everyday/Self, 1 to Scholarly, and 1 to Artistic. There were no changes from Performance to Mechanical/Scientific creativity; however, one additional participant went from dominant in Performance creativity to equally dominant in Self/Everyday and Scholarly creativity (not included in Figure 1). In the domain of Mechanical/Scientific creativity, of the 25 original group members, 15 remained in the same domain; 4 participants changed to Self/Everyday, 2 to Scholarly, 3 to Performance and 1 to Artistic. Of the 29 members of the Artistic domain, 18 remained dominant in Artistic creativity; 6 participants changed to Self/Everyday, 3 to Performance, and 2 to Mechanical/Scientific. There were no changes from Artistic to Scholarly creativity. A deeper analysis on the attributes of these groups and subgroups and the changes within them is first explored for those who remained in the same dominant domain, followed by those who change domains.

The following key is used for notation throughout these sections and on figures: ART = Artistic; M/SCI = Mechanical/Scientific; PERF = Performance; S/E = Self/Everyday; SCH = Scholarly. Additionally, all figures are viewable as interactive figures at https://sites.google.com/view/creativevariabilityincontext.

Analysis of Persistence in Self/Everyday Creativity

In the Self/Everyday category, 36 of the 38 who remained dominant from beginning to end of treatment were of an eastern education orientation. Of these, 24 were male, 12 female. Of the two from a western education orientation, both were male. The Chinese participants represented in this subgroup had an average English language proficiency of 0.89 (SD = 0.38) at the beginning of the treatment and an average proficiency of 1.34 (SD = 0.45) at the end of
Figure 1. Visual Migration of Beginning and End of Treatment Association with Dominant Domains.

Table 6
Crosstabulation of Beginning and End of Treatment Association with Dominant Domains

<table>
<thead>
<tr>
<th>Begin of Treatment</th>
<th>Self/Everyday</th>
<th>Scholarly</th>
<th>Performance</th>
<th>Mechanical/Scientific</th>
<th>Artistic</th>
<th>Dual**</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Self/Everyday</td>
<td>38</td>
<td>3</td>
<td>3</td>
<td>2</td>
<td>1</td>
<td>3</td>
<td>50</td>
</tr>
<tr>
<td>Scholarly</td>
<td>1</td>
<td>6</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>9</td>
</tr>
<tr>
<td>Performance</td>
<td>2</td>
<td>1</td>
<td>3</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>9</td>
</tr>
<tr>
<td>Mechanical/Scientific</td>
<td>4</td>
<td>2</td>
<td>3</td>
<td>20</td>
<td>1</td>
<td>0</td>
<td>25</td>
</tr>
<tr>
<td>Artistic</td>
<td>6</td>
<td>0</td>
<td>2</td>
<td>2</td>
<td>16</td>
<td>2</td>
<td>29</td>
</tr>
<tr>
<td>Dual*</td>
<td>4</td>
<td>3</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>13</td>
</tr>
<tr>
<td>Total</td>
<td>55</td>
<td>15</td>
<td>12</td>
<td>19</td>
<td>21</td>
<td>13</td>
<td>135</td>
</tr>
</tbody>
</table>

*Not included in the present study’s analysis
**Included in counts for persistent groups if one of the dominant domains at end still matched a beginning dominant domain
treatment. Average change in association with the dominant creativity domain of Self/Everyday was 0.11 (SD = 0.41). Additionally, the remaining domains of creativity also saw a positive mean change (S/E: M = 0.11, SD = 0.41; SCH: M = 0.19, SD = 0.47; PERF: M = 0.14, SD = 0.56; M/SCI: M = 0.07, SD = 0.51; ART: M = 0.07, SD = 0.50). Delineating the group further (see Figure 2), female members of this group who had an eastern education orientation at end of the treatment had an average English language proficiency of 1.46. This subgroup of eastern education females saw positive average changes across all creativity domains (Means: S/E =

![Subgroup Changes in Creativity Domains for Self/Everyday Persistent Members](image)

*Figure 2. Change in Creativity Domains by Gender, Education Orientation, and English Language Proficiency for those who Remained Self/Everyday.*
Male members of an eastern education background had an average English language proficiency of 1.23 at the end of the treatment, also with positive gains, albeit more modest, across all creativity domains (Means: S/E = 0.09; SCH = 0.20; PERF = 0.12; M/SCI = 0.01; ART = 0.10). For the two western education orientation male members of the Self/Everyday domain group (pre to post) participants only saw positive change in the Mechanical/Scientific domain, recording negative average change over the remaining creativity domains (Means: S/E = -0.23; SCH = -0.18; PERF = -0.25; M/SCI = 0.11; ART = -0.11).

**Analysis of Persistence in Scholarly Creativity**

Of the original 9 members of the Scholarly creativity domain, six remained dominant at the end of the treatment. This included 2 male eastern education participants, 3 male western education participants, and 1 female western education participant. For the two male eastern education participants, English language proficiency was 0.83 (SD = 0.24) at the start of the treatment and 1.67 (SD = .47) at the end of the treatment. The group also saw positive gains across all domains with Artistic creativity seeing the most average growth (SCH: M = 0.12, SD = 0.17; S/E: M = 0.26, SD = 0.21; PERF: M = 0.17, SD = 0.22; M/SCI: M = 0.18, SD = 0.39; ART: M = 0.66, SD = 0.26). While similar, the breakdown of the group into subgroups (Figure 3) shows a slightly different overall change. For the male eastern education participants, greater change was seen in Scholarly, Self/Everyday, and Performance domains (Means: SCH = 0.22; S/E = 0.32; PERF = 0.05; M/SCI = 0.16; ART = 0.72). Female western education members of
the group saw a wide range of change across domains (SCH = 0.00; S/E = 0.27; PERF = 0.50; M/SCI = -0.23; ART = 0.78). Male western education members also saw positive changes across all domains; however, these were below this domain’s group average except in Mechanical/Scientific creativity (SCH = 0.09; S/E = 0.21; PERF = 0.13; M/SCI = 0.33; ART = 0.58).

**Analysis of Persistence in Performance Creativity**
Four of the original nine members of the Performance domain remained from beginning to end of treatment. This included 1 male and 1 female from the eastern education system and 2 females from western education systems. English language proficiency mean for the two eastern education members was 0.50 (SD = .71) at start of the treatment and 1.67 (SD = 0.47) at end of treatment. For the four members, positive change was seen, on average, across all creativity domains with the greatest change occurring in the Artistic domain (PERF: M = 0.25, SD = 0.21; S/E: M = 0.11, SD = 0.16; SCH: M = 0.25, SD = 0.20; M/SCI: M = 0.22, SD = 0.20; ART:

![Figure 4. Change in Creativity Domains by Gender, Education Orientation, and English Language Proficiency for those who Remained Performance](image-url)
M = 0.47, SD = 0.45). Because this is the smallest subgroup membership, limited comparisons can be made. However, in line with other domains, the analysis is presented here (see Figure 4). The female eastern education member (English language level at end of camp = 1.33) saw modest positive change across all creativity domains (Means: **PERF = 0.20**; S/E = 0.27; SCH = 0.18; M/SCI = 0.11; ART = 0.22). The male eastern education member (English language level at end of camp = 2.00) saw positive changes in Performance, Scholarly, and Artistic creativity domains (Means: **PERF = 0.50**; E/S = -0.09; SCH = 0.36; M/SCI = 0.000; ART = 0.67). For the two female western education members, positive changes were again seen across all domains (Means: **PERF = 0.15**; S/E = 0.14; SCH = 0.23; M/SCI = 0.39; ART = 0.50).

**Analysis of Persistence in Mechanical/Scientific Creativity**

The domain of Mechanical/Scientific creativity had 25 original dominant members; of these, 15 remained at the end of treatment. This included 12 male eastern education members, 2 female eastern education members, and 1 male western education member. Overall English language proficiency for the eastern education participants at start of the treatment was 0.83 (SD = 0.31) and 1.29 (SD = 0.47) at end of treatment. In exploring change in the whole group, a mixture of results appeared. Several creativity domains declined, including Mechanical/Scientific while those that changed positively only changed marginally compared with other groups (**M/SCI: M = -0.08**, SD = 0.34; S/E: M = -0.01, SD = 0.24; SCH: M = -0.09, SD = 0.33; PERF: M = 0.01, SD = 0.40; ART: M = 0.04, SD = 0.39). Because of the negative trends across multiple domains within this group, it was important to understand if the trend paralleled within subgroups (Figure 5). The male eastern education (English language average at end of camp: 1.22) member’s change hovered near the whole group averages with slightly more positive results (Means: **M/SCI = -0.01**; S/E = 0.04; SCH = -0.03; PERF = 0.12;
Figure 5. Change in Creativity Domains by Gender, Education Orientation, and English Language Proficiency for those who Remained Mechanical/Scientific

ART = 0.07). However, the female eastern education (English language average at end of camp: 1.67) members saw greater decline in change than the overall average with the exception of Artistic creativity (Means: M/SCI = -0.33; S/E = -0.27; SCH = -0.32; PERF = -0.45; ART = 0.06). Likewise, for the male western education member of the group, change scores saw a greater decline, this time across all five creativity domains (Means: M/SCI = -0.45; S/E = -0.09; SCH = -0.28; PERF = -0.30; ART = -0.22).

Analysis of Persistence in Artistic Creativity
Finally, of 29 participants originally dominant in Artistic creativity, 18 remained dominant. This included 2 male eastern education members, 13 female eastern education members, 1 male western education member, and 2 female western education members. For the eastern education members, average English language proficiency at the start of the treatment was 0.98 (SD = 0.60) and 1.58 (SD = 0.41) at end of the treatment. Like most of the domains, overall change in creativity domains reflected positive growth (ART: M = 0.09, SD = 0.23; S/E: M = 0.33, SD = 0.41; SCH: M = 0.31, SD = 0.42; PERF: M = 0.33, SD = 0.38; M/SCI: M =
0.21, SD = 0.39). For the female eastern education members (English language average at end of treatment: 1.60), positive change occurred across all five domains (Means: ART = 0.10; S/E = 0.41; SCH = 0.31 PERF = 0.18; M/SCI = 0.10). For the male eastern education members (English language average at end of treatment: 1.50) positive change occurred across domains, except for in the dominant group of Artistic creativity (Means: ART = -0.06; E/S = 0.32; SCH = 0.77; PERF = 0.60; M/SCI = 0.50). For the female western education members, a much more modest and varied series of changes occurs (Means: ART = 0.22; S/E = -0.05; SCH = 0.05; PERF = -0.05; M/SCI = 0.28). For the male western education member change scores declined across all creativity domains with the exception of Self/Everyday (Means: ART = -0.11; S/E = 0.10; SCH = -0.10; PERF = -0.10; M/SCI = -0.11).

Analysis of Participants who Changed Domains

There were thirty-seven participants whose dominant creativity domain changed from beginning to end of the treatment. Of these, 22 were eastern education male participants, 12 eastern education female participants, 1 western education male participant, and 2 western education female participants. The participants, including western education members were predominantly in the younger age brackets of the participant cohort (Age 11: 1 eastern male, 2 eastern females, 1 western female; Age 12: 18 eastern males, 10 eastern females; Age 13: 3 eastern males, 1 western female; Age 15: 1 western male). The average English language proficiency for the eastern education participants at start of the treatment was 0.78 (SD = 0.40) and at the end of treatment was 1.26 (SD = 0.46). Despite changing dominant domains, the group, as a whole, still saw positive change in association with creativity domains from beginning to end of treatment (S/E: Mean = 0.11, SD = 0.69; SCH: Mean = 0.24, SD = 0.63; PERF: Mean = 0.20, SD = 0.73; M/SCI: Mean = 0.13, SD = 0.76; ART: Mean = 0.17, SD =
Table 7
Subgroup Changes in Creativity Domains—Grouped by Dominant Domain at Start of Treatment

<table>
<thead>
<tr>
<th>Starting Dominant Domain</th>
<th>S/E</th>
<th>SCH</th>
<th>PERF</th>
<th>M/SCI</th>
<th>ART</th>
</tr>
</thead>
<tbody>
<tr>
<td>Education Orientation</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(Eastern – E or Western – W)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gender</td>
<td>F</td>
<td>M</td>
<td>F</td>
<td>M</td>
<td>F</td>
</tr>
<tr>
<td>(Change in) Self/Everyday</td>
<td>0.50</td>
<td>-0.29</td>
<td>0.28</td>
<td>-0.27</td>
<td>1.09</td>
</tr>
<tr>
<td>Scholarly</td>
<td>1.05</td>
<td>0.17</td>
<td>-0.09</td>
<td>-0.41</td>
<td>1.00</td>
</tr>
<tr>
<td>Performance</td>
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<td>0.25</td>
<td>0.60</td>
<td>0.45</td>
<td>1.00</td>
</tr>
<tr>
<td>Mechanical/Scientific</td>
<td>1.44</td>
<td>0.22</td>
<td>0.18</td>
<td>0.06</td>
<td>1.45</td>
</tr>
<tr>
<td>Artistic</td>
<td>0.89</td>
<td>0.32</td>
<td>0.66</td>
<td>0.00</td>
<td>0.89</td>
</tr>
</tbody>
</table>

Table 8
Subgroup Changes in Creativity Domains—Grouped by Dominant Domain at End of Treatment

<table>
<thead>
<tr>
<th>Ending Dominant Domain</th>
<th>S/E</th>
<th>SCH</th>
<th>PERF</th>
<th>M/SCI</th>
<th>ART</th>
</tr>
</thead>
<tbody>
<tr>
<td>Education Orientation</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(Eastern – E or Western – W)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gender</td>
<td>F</td>
<td>M</td>
<td>F</td>
<td>M</td>
<td>F</td>
</tr>
<tr>
<td>(Change in) Self/Everyday</td>
<td>0.30</td>
<td>0.47</td>
<td>0.73</td>
<td>-0.27</td>
<td>-1.00</td>
</tr>
<tr>
<td>Scholarly</td>
<td>0.15</td>
<td>0.29</td>
<td>0.36</td>
<td>0.50</td>
<td>-0.37</td>
</tr>
<tr>
<td>Performance</td>
<td>0.37</td>
<td>0.25</td>
<td>-0.40</td>
<td>0.50</td>
<td>-0.70</td>
</tr>
<tr>
<td>Mechanical/Scientific</td>
<td>-0.02</td>
<td>0.11</td>
<td>0.22</td>
<td>-0.06</td>
<td>-0.85</td>
</tr>
<tr>
<td>Artistic</td>
<td>0.11</td>
<td>0.20</td>
<td>0.89</td>
<td>-0.28</td>
<td>-0.22</td>
</tr>
</tbody>
</table>
Figure 7. Change in Creativity Domains by Gender, Education Orientation, and English Language Proficiency for those who Changed Domains (Grouped by Beginning Associations)

0.62). Because this group represented a mixture of initial dominant domains, analysis followed additional delineations of subgroups (Tables 7 & 8, Figures 7 & 8). First, following the same analysis as groups persistent in creativity, the change domains group was put into subgroups by gender and education orientation, noting English language proficiency. In the female eastern education subgroup (English language proficiency at end of camp = 1.25), positive change was seen across creativity domains (Means: S/E = 0.20; SCH = 0.32; PERF = 0.26; M/SCI = 0.25; ART = 0.09). Likewise, the subgroup of male eastern education members (English
language proficiency at end of camp = 1.26) saw modest positive changes across creativity domains (Means: S/E = 0.05; SCH = 0.20; PERF = 0.26; M/SCI = 0.09; ART = 0.20). In contrast, the western education members, both male and female, saw a more varied set of changes, including negative changes (Female Western Education Means: S/E = -0.05; SCH = 0.09; PERF = -0.30; M/SCI = -0.17; ART = -0.05) (Male Western Education Means: S/E = 0.73; SCH = 0.36; PERF = -0.80; M/SCI = 0.22; ART = 0.89). Because of the variation in domains within this creativity group, analysis was also completed in subgroups by initial dominant
domain and by final dominant domain. This analysis showed slightly different trends. For instance, the western education female starting dominant in performance saw a decline in association with nearly all creativity domains; whereas eastern education males and females saw negative trends when starting from Mechanical/Scientific creativity. Those who switched to Scholarly creativity witnessed negative association with nearly all other creativity domains, including for eastern education male members within Scholarly creativity, indicating the change to this domain for these subgroup members simply saw the least negative change out of the domains. Full change means are presented in Tables 7 and 8 as well as visually in Figures 7 and 8.

**Trends in Individual Change Across Groups and Subgroups**

While looking at subgroup mean change scores for dominant domain groups can offer provocative insights into which subgroups may have experienced more or less change in association with particular creativity domains, it did not provide the full picture of learner variability nor did it allow for a completely accurate understanding of the degree of change available to learners. This is because the instrument used was not based on an infinite scale; rather, the scale was capped at a rating of 5. Thus, individuals who may have highly associated with a particular domain at the start of the treatment could remain highly associated with the treatment but see little mean change or even nominal negative change within subgroups. As such, analysis showing start of camp assessment and end of camp assessment for individuals while accounting for subgroup characteristics was also completed (Figures 9 - 14). The scatter plots created for these groups and subgroups gave a different perspective on learner variability and change in creativity.
In the group persistent in Self/Everyday creativity (Figure 9), the majority of individuals were clustered at the top range of the possible scale, allowing for little room for an increase in association with the dominant domain. Thus, while little change was seen in subgroups, including a negative mean change for western male participants, members of this group still remained high in association with only marginal difference from pre- to post-test. In the domain of Scholarly creativity (Figure 10), persistent members again saw high association both at the beginning and end of treatment; however, there was a much greater variation in starting and ending points across other domains. The small membership size of the Performance persistent
creativity group (Figure 11) meant little could be inferred from group analysis; however, it should be noted for this group that no change in the dominant domain for western education members was not for lack of association. Rather persistence in the dominant domain remained relatively the same from beginning to end of treatment. Likewise, western education members of the Mechanical/Scientific persistent group (Figure 12) showed high stability in their responses at beginning and end of treatment while their eastern education counterparts were able to find greater association with the creativity domains within the time frame of the treatment program. Finally, members of the persistent Artistic creativity group (Figure 13) followed a trend similar
to Self/Everyday and Scholarly creativities in their high initial association with the domain that remained high throughout the treatment. Overall, however, this analysis showed a general consistency of persistent members within their own dominant creativity groups, either as consistently clustered or consistently varied across particular domains of the full creativity profile.

Figure 11. Trend Analysis by gender and education orientation for Performance Persistent Creativity

For those who changed domains (Figure 14), there was significantly less consensus than what is visible in persistent creativity groups. Because of the limited number of western
education participants (here and throughout), it was difficult to determine how varied this subgroup was or would be. However, for eastern education participants, there was a much wider array of possible trends. While Self/Everyday and Scholarly creativities remained somewhat clustered, they were still less clustered than corresponding persistent creativity groups. Moreover, Performance, Mechanical/Science, and Artistic creativity indicated a great degree of variance from the clustered analysis.

**Understanding Patterns of Diminished Association**

The previous analyses shed light on the variations within groups, subgroups, and individuals. However, another aspect of learner variability within a given treatment deals with analyzing who a treatment may negatively impact. The cluster analyses throughout this section analyzed participants who saw negative change regardless of membership in domain groups and subgroups. Some variance, including perceived negative changes, can exist in any test, re-test situation; negative changes may also exist as individuals associate more with one domain and less with another following exploration in the treatment environment. What needed to be determined was who was negatively impacted outside natural or expected causes. Therefore, this group was defined by those who saw negative change across three or more of the five domains of creativity. Thirty of the 122 participants met this definition, representing 25% of the analyzed treatment group. Of these, 15 were male eastern education participants, 10 female eastern education participants, 4 male western education participants, and 1 female western education participant. Eleven individuals in this group were also members of the Scholarly Persistent group, 8 were also members of the Mechanical/Scientific Persistent group, and 3 were
also members of the Artistic Persistent group. The remaining individuals were all members of the Domain Change group. The average English language proficiency for both male and female eastern education subgroup members was approximately equivalent to other subgroups seen throughout (Female Mean = 1.30; Male Mean = 1.29). Female eastern education members saw a modest negative decline across all five domains (Means: S/E = -0.11; SCH = -0.19; PERF = -0.26; M/SCI = -0.40; ART = -0.24). Male eastern education members saw a greater decline across all five domains (Means: S/E = -0.37; SCH = -0.36; PERF = -0.34; M/SCI = -0.58; ART = -0.35). Female western education members saw more extreme changes with a notable positive
change in Scholarly creativity (Means: S/E = -0.37; SCH = 0.27; PERF = -1.20; M/SCI = -0.56; ART = -0.77). Male western education members paralleled closer to female eastern education counterparts (Means: S/E = -0.11; SCH = -0.18; PERF = -0.23; M/SCI = -0.09; ART = -0.14) (See Figure 15). While more than a third of the members in this group of diminished association were members of the Self/Everyday persistent group, it can be noted that the overall shift in Self/Everyday creativity still resulted in an overall positive trend with members relatively clustered along with eastern education and western education peers (see Figure 16). However, four members within this group shifted from other domains of creativity to Scholarly creativity.
This particular subgroup saw the most significant negative change out of any group or subgroup (see Figure 17). Within this subgroup, female eastern education members saw positive change only in Scholarly creativity (Means: S/E = -0.09; SCH = 0.73; PERF = -1.00; M/SCI = -0.78; ART = -0.67). Likewise, female western education members in this subgroup saw positive change only in Scholarly creativity (Means: S/E = -0.37; SCH = 0.27; PERF = -1.20; M/SCI = -0.56; ART = -0.77). Male western education members saw no positive growth in any creativity domain, instead with comparatively low change across all five (Means: S/E = -1.50; SCH = -1.00; PERF = -1.15; M/SCI = -1.39; ART = -0.72).
Figure 15. Change in Creativity Domains by Gender, Education Orientation, and English Language Proficiency for those with Diminished Associations
Figure 16. Trend Analysis by gender and education orientation for Diminished Associations with Creativity
Subgroup Changes in Creativity Domains for Members with Diminished Domain Associations (by Post Dominant Domain)

Figure 17. Change in Creativity Domains by Gender, Education Orientation, and English Language Proficiency for those with Diminished Associations (grouped by ending domains)
Chapter 5 Discussion

The data analyzed and trends made evident in this exploratory study showed there is, in fact, evidence for difference in creative abilities across domains. There was also evidence that changes within and across domains are distinct from what was seen in whole group averages. Additionally, some of the changes and associations could be linked to group and subgroup features, while others were more likely due to interaction in the environment, according to what the treatment facilitated or suppressed. Overall, though, the exploratory analysis provided a basis for understanding domain-general and domain-specific creativity in light of an interacting treatment. Such a perspective is necessary for future research and effective implementation of creativity in education.

This chapter discusses these potential explanations for the variability in creativity types as evidenced in the data analysis as well as potential explanations for the malleability of creativity seen after interacting with the treatment. The results follow the pattern of layers exploring influences of identified variables, including education orientation, gender, English language ability. The chapter also theorizes potential interactions attributed to either analyzed variables or treatment conditions or both. It then outlines the limitations of inferences drawn and identifies future lines of study. Overall impact and importance are discussed in closing.

Summary of Results

The current study had two overarching goals: to explore how domains of creativity were variable within the treatment for both Chinese and non-Chinese adolescents and to explore how malleable those types of creativity were. First, the study sought to understand the high-level trends that exemplify how creativity domains were variable. It described the different membership characteristics, features, and associations within five specific domains of creativity.
Exploring broad group membership enabled the understanding of how these domain groups may vary when compared to the whole treatment, compared to each other, and when separated into subgroups. There was a notable difference in distribution in association with domains between eastern and western education participants. Additionally, there were distinct trends within groups and subgroups makeup that gave potential insight into domain-specific variability. Second, within these creativity domain groups, the study sought to understand malleability within creativity domains from beginning to end of treatment. Initial findings indicated an overall positive change in association across creativity domains after participating in the treatment. Patterns were also found based on the separation of those who persisted within the same domain of creativity versus those who changed associations to a new domain creativity after the treatment. These changes were additionally analyzed at the subgroup level to understand how changes varied across cultural, gender, and cognitive factors. For persistent domain subgroups, evidence was found for variability in the makeup of creativity profiles and how these subgroups changed both in comparison with subgroups in the same persistent domain and when compared to other persistent domains of creativity. Similar evidence was found for participants in the changing domain group; however, this group also saw greater subgroup variability and a wider range of scores across the domains, potentially attributed to age and treatment interaction.

Finally, this study intended to take particular note of the membership characteristics and features of changes associated with negative interaction with the treatment. Within this analysis of diminished association with creativity domains, wide variability was found; however, some trends in associations with particular creativity domains and cognitive abilities were seen.

**Variations and Patterns in Creativity**
In initial analysis, the distribution of participants across creativity domains at the beginning of camp was markedly different between eastern and western education orientations. In this treatment with these participants, creativity varied equitably across all five domains for western education participants. However, domains were clustered for eastern education participants, the majority (81%) associating with Self/Everyday, Artistic, and Mechanical/Scientific creativity. This left only five participants in each of the two remaining domains, Scholarly and Performance (4% of the eastern education participants, each). Other studies utilizing the K-DOCS have also found such clustered patterns of association with one or more domains. These majority associations have generally been attributed to cultural or group norms (Meerhaeghe & Dolins, 2017).

The domains, in this case, that saw the most association for eastern education participants conform to areas that are perceived culturally as important. For instance, the higher proportion of eastern education participants in Mechanical/Scientific creativity parallels the importance placed on STEM (science, technology, engineering, and math) fields in China’s education and high stakes testing systems. Science and math, two of the tested subjects on high school and college entrance exams, are taken far more seriously and thus may receive greater both greater emphasis and access within schools (Emler et al., 2019). Additionally, China’s call for innovation and creativity, including in education, have been centered in recent decades on innovation within science and technology that are seen as key areas for revitalizing China’s global significance. While some expansion has attempted to broaden this scope to include humanities and social science, calls for creativity outside of STEM areas are vague and include such directives as “cultivate creative thinking” or “generate novel ideas” (Dello-Iacovo, 2009; Pang & Plucker, 2012; Tam et al., 2014). Programs and policies that have clear implementation
guidelines and support, in contrast, have a disproportionate focus on science and technology innovation (Cao et al., 2009; Pang & Plucker, 2012).

In the case of Artistic creativity, while not tested subjects, music and art are nonetheless features of Chinese education, including time in these subjects as electives as well as through extra-curricular activities (Woronov, 2008). Additionally, these areas are viewed as creative outlets that can be practiced and improved upon as a means toward personal “excellence” (Niu & Kaufman, 2013).

The predominance of eastern education participants in the domain of Self/Everyday creativity was also not surprising. As noted before, interpersonal and intrapersonal features are associated with Self/Everyday creativity. These may correlate to the collectivist priorities of the culture. Items such as “helping other people cope with a difficult situation,” “thinking of new ways to help people,” and “getting people to feel relaxed and at ease” all cater to the cultural importance of “moral education” and contributing to one society (Craft, 2008; Lockette, 2012; Ng, 2003; Niu & Kaufman, 2013; Woronov, 2008).

Additionally, at the top level, gender was not equitably distributed within the five domains for participants. Rather patterns in creative variability that conform to gender stereotypes were found across domains. In the domain of Self/Everyday creativity, 42% of the male eastern education participants were represented. Not dissimilarly, 34% of the female eastern education participants were found in Self/Everyday creativity. However, 25% of the male eastern education sample associated with Mechanical/Scientific creativity and only 11% with Artistic creativity. In contrast, female eastern education participants had the highest percentage in Artistic creativity (41%), and a much smaller percentage within Mechanical/Scientific (11%). Additionally, while generally more equitably distributed across
creativity domains, western education female participants saw some tendency toward gender stereotypes. No female western education participants were associated with Mechanical/Scientific creativity. Instead, more than half were associated with either Performance or Artistic creativity domains (3 and 2 out of 7, respectively, accounting for 71% of this subgroup). These trends were not surprising. Creativity, when defined as domain-general, has shown no consistent patterns of difference in genders (Baer & Kaufman, 2008; Kaufman, 2006). However, domain-specific creativity has been subject to stereotype threats in which social and visual/artistic forms of creativity tend toward association with females and science/analytic/physical forms of creativity tend toward association with males (Kaufman, 2006)(Faletič & Avsec, 2019; Kaufman, 2006). Thus, in this treatment with these participants creative variability largely followed gender stereotypes.

Another series of patterns in creative variability became evident amongst those who changed dominant domains. Western education participants saw fewer members within this group, having an overall higher degree of persistence in the same dominant domain than their eastern education peers. Twelve of the fifteen western education participants remained in the same dominant domain group from beginning to end of treatment (80%). In contrast, only 69 of the 120 eastern participants (58%) saw the same consistency. This could be attributed to at least two influential factors. First, the average eastern education participant was approximately two and a half years younger than the average age of international participants. Adolescence is a time of significant developmental change, including development of higher order cognitive functioning and identity development (Hansen et al., 2019; Weinberger et al., 2005; Zimmerman, 2008). However, metacognitive traits and awareness of self-identity do not come into full existence overnight. They develop throughout adolescence, particularly through experiential
learning (Weinberger et al., 2005). Western education participants who were somewhat older than their eastern education peers may have had more developmental opportunity to understand and realize their own creative selves, resulting in higher persistence in dominant domains of creativity. The second potential variation factors in cultural differences. Western education participants were all invited from schools where problem- and project-based learning were being implemented in some form and where innovation, creativity, and/or entrepreneurialism were being actively pursued. These education paradigms naturally embrace and utilize experience-based learning in authentic manners (Zhao, 2012, 2018a). Therefore, not only would international participants have had the potential of more time within key developmental stages, but within that time they likely had greater opportunity to explore and experience different implementations of creativity in both domain-general and domain-specific ways. This would have the potential to further enable the formation of their creative self-identities. The change for the eastern education participants, however, did not automatically constitute a negative outcome. Rather, it was theorized that the treatment allowed exploration of different domains and emphasized the importance of pursuing individual strengths and talents. Thus, particularly for a period of identity development for younger participants, change could be seen as the treatment facilitating personal exploration into diverse pathways of creativity.

Finally, at the top level, it was difficult to determine if and to what extent English language proficiency interacted with group characteristics and makeup (see Limitations). While this was likely the most influential cognitive factor, the scale of the instruments used may not have been nuanced enough to fully explore this aptitude. Instead, overall proficiency averages at the beginning and end of treatment were very similar across domains with the exception of Performance creativity (M= 0.50 at beginning of treatment) who had an exceptionally small
group size and participants whose domain changed (M = 0.78 at beginning of treatment). For those who changed domains, it should be noted average ending English language proficiency was not exceptionally low when compared to other dominant domains of creativity and also showed little difference between males and females (M = 1.26 and 1.25, respectively; 1.26 combined). Thus, for this group of eastern education participants, as measured here, level of English language proficiency did not appear to be a contributing factor to creativity domain variability or malleability of creativity domains.

Changes in Creativity

At a top-level view, the treatment showed positive significant change in association across all domains. When taken holistically, these averages indicated a treatment population that gained in overall creativity (domain-general) regardless of domain (McKay & Gutworth, 2019; Meerhaeghe & Dolins, 2017). Thus, in fostering creativity, the treatment, on average, was successful. Analysis across subgroups shed light on some caveats for this statement, and additional trends were made evident in certain domains. In the domain of Self/Everyday creativity, all subgroups across all domains saw positive change in association with the domain with the exception of the Mechanical/Scientific subgroup of female eastern education members and the Performance subgroup of male eastern education members. Since Self/Everyday creativity relates to interpersonal and intrapersonal skills, it was theorized the treatment interacted successfully in a way to support understanding of oneself and collaboration with and commitment to others. Thus, the following factors showed support for the treatment’s goals of value creation and interdependence: a majority of participants persisted within the domain of Self/Everyday creativity; a large portion of participants changed to this domain; and positive
change was noted for the majority of subgroups. However, initial associations may have also been attributed to cultural norms (see above).

Some group variability was noted across domains, particularly regarding gender affiliations and cultural influence (as defined by education orientation). Learner variability was notably more complex than top level views, though. In the subgroup analysis exploring the complexities of malleability, additional trends were found. For those who remained dominant in Self/Everyday creativity, eastern education participants (both male and female) saw an average positive change across the full creativity profile. Female eastern education participants saw a slightly greater degree of positive change than their male peers; however, they were also slightly higher in English language proficiency (Female M = 1.462; Male M = 1.231). As noted above, Self/Everyday creativity actually saw a positive average increase across all eastern education subgroups, regardless of dominant domain (including for those that changed domains) with the exception of the (2) female eastern education members of the Mechanical/Scientific domain who notably saw declines across nearly all domains in the full creativity profile and the (1) male eastern education Performance dominant member. As the treatment encouraged collaboration and entrepreneurial intentions to authentically contribute to a community outside of oneself, this could, as noted before, be attributed to treatment interaction or cultural influences.

In the Scholarly persistent group, the first notable change was the loss of the female eastern education subgroup. While a very small portion of the full female population, the loss of original members of this particular subgroup should be noted. Again, gender stereotype threat may have played some part in this change of association as many items related to non-fiction and technical writing—subjects and activities often associated with STEM. Although additional items dealt with debate, argumentation, and critiques – activities that could be associated with
social science fields such as law – these could still be perceived on the technical level of “hard
sciences.” Interestingly, within the three persistent subgroups, all saw the greatest positive mean
change for Artistic creativity. Moreover, not only did the subgroups within Scholarly creativity
see the greatest mean change for Artistic creativity, but every individual within the subgroups
saw positive change in association with Artistic creativity. This again, could be attributed to
treatment interaction as there were far more opportunities to engage in Artistic forms of
creativity than Scholarly forms of creativity. For instance, participants were able to take part in
photography, creation of photobooks, videos, video-journals (v-logs), creation of group logos
and flags, and other artistic outlets. Artistic scores also had low associations to begin with which
may have simply allowed more room for change when exposed to the domain within the
treatment (Minimum at beginning of treatment = 2.22; Maximum at beginning of treatment =
3.44; Minimum at end of treatment = 2.78; Maximum = 4.44). Whether such an increase in
association in a non-dominant domain is considered positive or not is beyond the scope of this
exploration. It can be said, however, that this increase in association with Artistic creativity did
not seem to come at the expense of an association with Scholarly creativity.

The domains for Performance creativity and Scholarly creativity had the fewest initial
members, having only nine members each. However, those who persisted in association with
Performance creativity formed the smallest subgroup, even over Scholarly creativity, with only
four members. The lack of membership within Performance groups and subgroups limited in-
depth exploration.

Like the Scholarly group, the Mechanical/Scientific group had only a small proportion of
female participants and only from an eastern education background. Of the few initial female
members, only two persisted in the Mechanical/Scientific group. When viewed as a subgroup,
these female participants appeared to decline across nearly all domains. However, the variability between the two members of this subgroup could be easily misunderstood when depending on averages. For one participant, there was comparatively low association (Min = 3.11; Max = 4.33) across creativity domains that all saw diminished association (Min = 3.00; Max = 3.56). In contrast, her peer saw some decline across domains; however, associations were initially higher (Min = 4.00; Max = 4.67) and remained higher (Min = 4.36; Max = 4.78). The dichotomy seen here illustrated the caution that should be used even when analyzing subgroups. The male eastern education subgroup for Mechanical/Scientific persistent creativity is larger and offered more insight into patterns of change. For instance, this subgroup saw negligible mean change (0.04) in Self/Everyday creativity and actually saw some negative mean change in Scholarly (-0.03) and Mechanical/Scientific (-0.01) creativity. However, these three domains all shared the individual tendency to be highly associated initially with these domains. In fact, in the domain of Mechanical/Scientific creativity, only one individual had an average below four at the beginning of treatment. Thus, there was little room for notable increase in association with the domains. In contrast, there was great variation in association with Performance and Artistic creativity for this subgroup. From this analysis, it would seem a high association with Mechanical/Scientific creativity for this subgroup was also associated with higher Scholarly and Self/Everyday creative tendencies.

In the final persistent group, Artistic creativity, subgroups were, as noted nearly opposite in makeup as that of the Mechanical/Scientific creativity groups. Predominantly female in association, the persistent Artistic creativity group actually saw six of its relatively few male members shift to other dominant domains. Across remaining persistent subgroups, an interesting difference was found compared to other groups. While many groups had the tendency to cluster
around the dominant domain and one or more additional domains, there was great variability in the full creativity profile within Artistic creativity subgroups. Association with Artistic creativity began and remained high while all four other domains had a wide range of association and change. Therefore, for this population and context, there was a high confidence in association with Artistic creativity that superseded any trends in association with other domains. The treatment’s activities throughout the two weeks, as noted before, likely supported the high association and persistence within this group.

The last group looked at those who changed dominant domains, rather than persisted in a single domain. There was significantly more variability visible across creativity domains in subgroups when analyzing mean changes across domains. Additionally, there was little that could be gleaned from trend analysis in beginning and ending associations. Instead patterns of malleability were found in the overall group makeup, as discussed above.

**Side Effects and Diminished Associations**

In addition to understanding the variability in creative domains and how creativity can change within groups and subgroups, there was a critical component of understanding how aptitudes interacted with one another in context so as to account negative impacts on learners. When analyzing those with diminished association, as defined by a negative change across three or more domains, distinctions were not at first readily visible. English language ability, while low, was not, on average, significantly lower than elsewhere across domains. In fact, the Mechanical/Scientific persistent creativity domain had a lower average English language score than those who with diminished associations. However, one notable point across this subgroup was that despite only requiring negative change across three domains, subgroup averages saw a negative change across *all* creativity domains with the exception of Performance creativity for
the female western education subgroup. This implied a lower association with domain-general creativity, not necessarily exclusive to domain-specific creativity. Additionally, when delineating these subgroups further according to beginning and ending dominant domain of creativity, greater negative change was found for the male eastern subgroup of beginning Self/Everyday creativity, the female western subgroup for beginning Performance creativity, and both male and female eastern beginning Mechanical/Scientific creativity. This trend was parallel for the same subgroups that ended in these dominant domains with less significance for the male eastern Mechanical/Scientific subgroup.

In this analysis, though, one domain stood out even more as succumbing to potential side effects. Scholarly creativity, as noted above, saw a loss of its persistent female eastern education subgroup. In addition to this loss of association, members who switched to the Scholarly domain from another area, saw overall negative trends in the subgroup’s full creativity profiles. Subgroup members who changed to Scholarly creativity saw positive change in this domain only (female eastern and western education subgroups) or not at all (male eastern education subgroup). The small original association with this domain, along with changes from the domain, and diminished association with the domain all warranted further investigation. It is possible that the treatment itself, which provided fewer opportunities for traditional forms of research and debate, failed to meet the creative needs of these subgroups. It is also possible that a program that promoted itself on innovation, creativity, and entrepreneurial endeavors would not generally attract participants whose predilections tend toward more traditionally academic pursuits. Additionally, those within this group may have defaulted to what seems comfortable for traditional education associations. That is, a lack of identification with other domains of creativity may have simply left Scholarly creativity as the default highest association. However,
because the goal of understanding learner variability is to meet students’ individual and group needs, findings such as this should warrant discussion from program administrators. If program goals do not match learning needs of all types of creative participants, recommendation of alternate programs to better suit individual needs may be beneficial, or program goals and opportunities should be expanded to better include all domains.

**Limitations**

While there is a significant amount of data that can give insight into creativity variability, there are certain limitations that must be noted. The greatest limitation is the difference in population between the eastern education participants and the western education participants. Because the treatment was hosted in China and international participants invited through assisting schools, the division was expected. However, the limited number of international participants inhibited comparisons that could be made between the two subgroups. The number of international participants also diminished confidence in patterns and trends for their subgroups. For instance, while international participants were fairly equally distributed across creativity domains, it could not be said with confidence that this trend would hold true with a greater number of participants or if it would more closely parallel the distribution of their eastern education peers.

Another limiting factor concerning populations may be found in the recruitment process. All participants in the treatment were made aware of the program’s objectives and goals. As participants elected to join a program that was deemed different from traditional education programs, it is possible distributions, groups, and trends were distinct from what would be found in more traditionally oriented environments, whether influenced by eastern or western cultures. The smaller group memberships in domains such as Scholarly and Performance creativity might
see more proportionate membership; the treatment may have simply not appealed equally to individuals with such inclinations. Minimally, the comparison of a control group would add to the understanding of what may be attributed to treatment interactions versus other group and subgroup variables.

Throughout the groups and subgroups, limited findings were available for the cognitive aptitude of English language proficiency. These limitations were at least twofold. First, the scale used for rating Chinese participants only allowed for four levels of ability with a fifth added to represent native level fluency for international participants. A wider ranging scale may have allowed for greater distinctions between levels, enabling a closer analysis of subgroups and changes as influenced by language ability. Second, as the measures were intended for more informal and formative purposes to provide participants and parents with growth report cards, the measures themselves were not tested for validity and reliability. Scoring, too, may have reduced validity and reliability. Scores were assessed by the principal investigator in the role of a staff researcher along with a second staff researcher; however, due to time and limited availability, these were divided between the two researchers and only occasionally cross-checked for inter-rater reliability. Use of a more formal foreign language aptitude measure, complete with formalized scoring, could provide more exploration and understanding of the interaction of language as a cognitive ability within the treatment.

Likewise, the use of the K-DOCS measure also had some limitations in this application. The instrument was chosen specifically for its domain-specific nature as a tool that can aid adolescents in identifying unique interests and talents. When separated in this matter, though, it does limit how well it can give insight into individuals’ domain-general creativity. One alternative is to use the K-DOCS as a domain-general instrument, creating aggregate profiles of
how creative an individual is by totaling and averaging across domains (McKay & Gutworth, 2019; Meerhaeghe & Dolins, 2017). Alternately, the K-DOCS could be used as an evaluative measure with a supplemental instrument used to measure change in creativity or degree of creativity (Kaufman, 2019). When used in such a manner, it would not need to bear the emphasis of understanding both domains of creativity and degrees of association or change within them. However, here, too, it could be argued the instrument was able to show how the treatment may or may not have changed how participants felt about the domains of creativity. Regardless, a supplemental measure would add significant richness to the understanding of creativity within groups and subgroups. Such a supplemental measure was, in fact, utilized with eastern education participants as part of the student and parent report. A variation on the figural drawing found in the Torrance Test of Creative Thinking measured divergent thinking – a trait often associated with creativity – was used at the beginning and end of treatment (Acar & Runco, 2012). Participants were scored on fluency, elaboration, flexibility, and originality. However, as international participants did not complete the measure, the scores were not used within this exploratory analysis.

The K-DOCS measure may also encounter some perceived limitations as it is a self-report measure. The K-DOCS measure is able to counter some limitations as it asks respondents to measure not how creative they are cumulatively but how creative they are within domains compared to peers similar in age and experience (Kaufman, 2012). Additionally, creative self-report measures have been shown to have promising consistency, reliability, and validity when implemented in low-stakes environments and when reporting creative activities (Silvia et al., 2012)(McKay & Gutworth, 2019; Silvia et al., 2012). As the K-DOCS was presented in a way so as to support students’ understanding of their own creative identities and not as a “right” or
“wrong” assessment, it likely did not merit the degree of concerns as some self-assessments. Nevertheless, this limitation is recognized, particularly without the benefit of a secondary confirmatory measure.

Finally, it should be noted that the variables selected for groups and subgroups do not fully represent the range and scope of influencing variables that could have been used. Age, for example, was reported in places as part of descriptive demographics but was not factored into each subgroup formation as the majority of participants were around the age of 12; however, developmental differences between the youngest participants at age 11 and oldest participants at age 18 may account for some differences in domain associations, as noted above. Likewise, the preponderance of Asian backgrounds limited the meaningful use of racial/ethnic variables, but this would potentially provide additional avenues of analysis for international participants. The limitations noted throughout this section do not diminish the creative learner variability that was found within the study nor the potential interactions with the treatment; however, they do provide insights into implications for future research.

**Implications for Future Research**

There are many directions this research could continue. The limitations outlined above provide direction for future analysis of the variability found in creativity domains and potential interactions between learners and the environment. As an exploratory study, variables were selected that were considered most applicable to the full treatment group. However, the discrepancies in size between the two education orientation groups limited the comparisons that could be drawn. An exploration of the domains and their malleability with a larger international population would be beneficial. There are also additional variables available for both groups that could facilitate their exploratory analysis separately. For the eastern education participants,
exploration should be conducted that includes the divergent thinking scores available. For western education participants, if a larger sample size is obtained, additional studies should incorporate associated country, ethnic background, and age as these are all variables that could interact in unique ways across groups and subgroups.

Considering the variability found from top levels of analysis to group and subgroup analyses, the study would merit a renewed analysis with a new cohort. Should the study be revisited in such a manner, it is recommended that additional instruments as outlined within the limitations section be utilized. In fact, for a true understanding of the interactionist nature of aptitude-theory, utilizing a variety of instruments is largely recommended (Gustafsson & Undheim, 1996; Kieft et al., 2008; Kupermintz, 2002; Snow, 1992) and would facilitate deeper exploratory studies or, with a comparison group in place, would facilitate experimental procedures to better understand effectiveness of the treatment for its goals.

Finally, this study shed light on the distinct and rich layers that give new insight into a given treatment. As such, future educational research, inclusive of but not limited to creativity research, should take into account learner variability and treatment influence through an interactionist approach. Such studies should utilize variables that are most relevant to success within a given treatment while fully understanding the conditions of the treatment itself. From such an interactionist perspective, it could be understood how individuals and groups thrive or fail to thrive within a given environment (Snow, 1992; Snow, 1996; Snow, 1997; Snow et al., 1996; Zhao, 2018b).

**Conclusion**

This study highlighted how creativity domains vary in a specific treatment between the relevant groups and how malleable these domains were. While there were similarities found in
groups and subgroups, distinct differences and clear trends were visible when analyzed outside of potentially misleading averages. Exploring domains of creativity also provided a shift from the traditionally academic scope of learner variability. As a concept that features in twenty-first century education, embracing the diversity found in creativity is critical to fostering its exploration and growth. This exploratory study can provide initial understanding in creativity’s variability and malleability. As more research seeks to understand these patterns and embrace learner variability across aptitudes, environments and treatments can continue to adjust to meet learner needs in personalized settings designed to facilitate the fullness of human potential.
References


Chan, S., & Yuen, M. (2014). Creativity beliefs, creative personality and creativity-fostering practices of gifted education teachers and regular class teachers in Hong Kong. Thinking


Pape, B. (2018). Learner variability is the rule, not the exception.

Review. Creative Education, 5(03), 145.


National Campaign to Prevent Teen Pregnancy.


