

Diversity by Design: Analogizing and Formative Investigation across Disciplines and Cultures

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Abstract

This article addresses the relatively neglected issue of leveraging variations in the analogies and creative outcomes across different national and design cultures for innovations. It argues that the formative investigation of cultures as an expression of their analogies differs in important ways from other innovative behaviors. Formative investigation of various cultures embeds various underlying cognitive representations that enable them to formulate, experiment with and evaluate new or vague ideas and solutions. We develop and test hypotheses by examining the formative investigation and creative outcomes of 250 millennial students from different national and design cultures. That is, male and female students who are Caucasian American, Asian or Hispanic and belonging to industrial, graphic or craft design disciplines. The results demonstrate differences in the formative investigation and creative outcomes of the various cultures. In conclusion the study argues a key aspect of creativity outcomes and innovation relevant to leverage of knowledge across cultures for innovation is the cognitive representations that differentiates one culture from another and facilitates formative investigation in unique ways. We argue for the leverage of this diversity to enhance creative outcomes in marketing.

Keywords: Diversity, analogies, formative investigation, culture, design, creative outcomes

1. Introduction

The diversity in creative thinking amongst different disciplines and cultures can be leveraged for innovation and marketing success (Nonaka et al., 2001). This diversity can stem from the divergent analogies utilized across different cultures and disciplines. Analogizing is a dynamic heuristic for idea generation that promotes comprehension of unfamiliar design situations in terms of familiar ones (Casakin et al., 2015). Analogizing is a process that is directly linked to formative investigation. Formative investigation involves experimenting with new ideas and solutions before their implementation (Kleyson and Street, 2001). Several companies are exploring innovation in new market with impactful new products, such as Apple, and Unilever (Financial Times, 2013). Such innovations that are unique require significant ability to leverage cross-culture and cross-design as resources for innovation. In this study we investigate how the analogies of different cultural and design disciplines can be leveraged for enhanced creative outcomes or innovation. Our central research question is how the differences in analogies hence formative investigation of individuals from diverse cultures and design disciplines result in different creativity outcomes. The perspectives we employ on analogies extend work on cross-cultural and cross-disciplinary creativity and innovation, and address the following research gaps in extant literature. Additionally, our contribution has implication for issues of cross-cultural equivalence in research. Extant research has discussed cross-cultural considerations in innovation (e.g. Elliot and Nakata, 2013; Westwood and Lowe, 2003) without considering how the analogies of the different cultures impact creative outcomes.

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In contrast to some research studies that explore the impact of different engineering and architectural teams (e.g. Casakin and Badke Schaub) on creative outcomes, we suggest that creative outcomes that are unique and relevant to emerging markets emerge from analogies represented by formative investigation. The way team members perceive and understand reality can vary according to their different cultures and design disciplines and thus their knowledge. These have an effect on their analogies, expressed as their formative investigation in the context of innovation. This selective consideration of differences in analogies is necessary for simultaneously leveraging multiple knowledge contexts for creative outcomes that are unique and relevant to global markets. Second, previous research has approached the orientation of knowledge for innovation in a selective and perhaps dichotomous way. One school of thought has focused on innovation from a combination of knowledge from various domains such as government, industry, and academia (e.g. Leydesdorff & Meyer, 2006), while another has discussed knowledge as related to cultural orientations (e.g. e.g. Moller & Svahn, 2004). In this paper we give equal attention to both knowledge combinations from different domains and knowledge related to cultural orientation by examining the representation of knowledge in the form of analogies and as expressed in formative investigation by designers from different cultures which result in differentiated creativity outcomes. This dual focus allows us to create a more balanced picture of how differences in cultures and design disciplines can lead to differentiated creativity outcomes.

To answer our research question, we administered a survey on innovative behaviors to 250 of design students (industrial, graphics and craft designers) from different national cultures and design disciplines at a large University in the Midwest. Design is an ideal domain to study analogies and formative investigation since by definition design situations are ill-defined, non-routine, extremely complex and unique (Suwa et al. 1999). The student population was considered ideal since students are millennial who are better positioned for a rethinking and redesign of systems in line with the new realities of a rapidly changing world. The results of the survey support the hypothesis that analogies and their expression as formative investigation differ across different cultures and results in differences in creative outcomes. These results have implications for research on analogies in a cross-cultural context. Our approach is particularly useful for multinational firms in emerging markets who will be positioned to leverage cross-cultural analogies for global innovations. This paper is organized as follows. We first review the literature on analogies within and outside the fields of new product development and marketing and provide an exposition on analogies across cultures and design disciplines. Second, we build on extant literature to develop hypotheses in relation to the differences in analogies and formative investigation of American, Hispanic and Asian designers. Third, we empirically analyze results from representative samples from American, Hispanic and Asian designers and derive recommendations for both research and practice. Fourth, we conclude with a discussion of the paper's contributions and directions for future research on innovations in emerging markets and implications for cross-cultural equivalence in research.

2. Literature Review and Hypotheses Development

The literature and related hypotheses draws on contemporary theoretical accounts on national cultures and design disciplines that expose how analogies and knowledge representations influence creativity differ across cultures and disciplines.

2.1. Analogies and Formative Investigation across Cultures and Disciplines

Analogies are a tacit form of knowledge deeply rooted in individual's experience and ideals or values (Nonaka et al., 1998). Analogies are thus a cognitive framework of informational, relational, and emotional components of knowledge (Nonaka and Takeuchi, 1995). Such tacit insights or emotions, embedded in the cultural contexts, are difficult to verbalize. Analogies involve the retrieval, and transfer of previous knowledge from a familiar situation (the source) to a situation in need of clarification (the target). Establishing associations between familiar relations in the source and possible relations in the target enables the new situation to be understood in terms of a known situation (Holyoak & Thagard, 1995). Spatial analogies are accurate mental representations of spatial layouts, allowing perspective taking, reorientation and spatial inferences (Tversky, 1993). Formative investigation therefore leverages analogies to look critically at reality, investigate unconventional alternatives and analyze situations from unique perspectives (Breuning, 2003). This critical look at reality involves analyzing ideas and separating the bad ones from the good ones (Khurana and Rosenthal, 1998). The way in which analogies are developed is dependent on the context, and social setting in which they are constructed (Marshall, 2007). Individuals in teams therefore apply their analogies in their formative investigation to generate creativity outcomes. Formative investigation involves experimenting with new ideas and solutions before their implementation (Kleyson and Street, 2001).

Prior research indicates that such an approach of experimenting with new ideas and solutions is essential to firm innovation and fosters creative ideas and solutions in new product development process (Thomeke, 2001). We therefore focus on formative investigation as an essential factor for differentiating analogies across cultures and disciplines that influence differences in creative outcomes during innovation. Consequently, we propose the following hypothesis:

H1: Formative investigation as an expression of analogies is positively related to creative outcomes across different cultures.

2.2. National Culture, Analogies and Creative Outcomes

To the extent that analogies represent individual cognition systems that are created to interpret external environments, individuals with common cultural backgrounds and experiences could share reasonably convergent analogies. DiMaggio (1997) indicates that culture is a network of interrelated schemata, with analogies as the "ties" that create routes along which generalization and innovation happen. Individuals from different cultural backgrounds are expected to possess different experiences and exhibit unique perceptions of the outside world. The divergence of analogies could get deepened if individuals with different cultural backgrounds do not communicate frequently among themselves. For example, research in psychology suggests that East Asians and Americans have different cognitive styles (Markus & Kitayama, 1991; Nisbett & Masuda, 2003). East Asians tend to engage in holistic thinking by allocating greater attention to contextual information, such as background objects in a picture, and at higher levels of cognition often associate concepts based on ecological relations (Markus & Kitayama, 1991). Americans, on the other hand, tend to be analytic in cognition and focus on focal information, such as foreground objects in a picture, and categorize based on shared properties (Wang, Fussell and Cosley, 2011). In addition, people from different cultural backgrounds may also have differences in their semantic networks that may enhance diversity (Wang, Fussell and Cosley, 2011). Sanchez and Gunawardena (1998) expose that Hispanics show a preference for an action-based, active approach to learning and a preference for concrete over abstract; elaborative processing, and judgment over perception. Latino participants are also more capable of solving a problem framed metaphorically than Anglo participants (Walheimer, 2010).

The above expositions indicate that the entire structure of the analogies is derived from the experiences of each individual that are rooted in the national culture of the individual. It follows that individuals from different cultures and disciplines may act on identical information in different ways (e.g. Arthur, 1992). Prior studies have provided empirical support for this view with a focus on relations between national culture (conceptualized as Hofstede's dimensions) and creative innovation outcomes (Shane, 1992, Shane, 1993). Westwood and Low (2003) argued that cultures are innovative within the context of their own system. Elliot and Nakata (2013) also relate such creative behaviors to culture by the exposition that whilst Japanese divergent creativity leads to adaptive reaction and a preference for incremental innovation strategy, American divergent creativity leads to disruptive outcomes and a preference for radical, episodic, innovation strategy. Westwood and Low (2003) conclude that culture shapes creative and innovative processes, but the relationship should be understood in subtle and nuanced ways. Analogies as formative investigation of different national cultures therefore become salient to creative outcomes and innovation. We thus suggest the following hypotheses:

H2 (a): There is a difference in the expression of analogies as formative investigation across different national cultures.

H2 (b): There is a difference in the creative outcomes across different national cultures.

2.3. Design Discipline, Analogies and Creative Outcomes

Design is integral to creativity disciplines, such as art, architecture, and engineering (Mullin, 2010). Design is a process that transforms creative ideas into concrete products and as such unlocks creativity in the innovation process (Hollanders and Cruysen, 2009). Weisberg (1993) and Gero (2000) suggested that design not only fosters novelty, but also generates valuable and unexpected solutions. Designers are creative individuals who are able to take risks to challenge the unknown, have a strong motivation to achieve personal goals, and eagerness to succeed in their discipline (Hanna & Barber 2001). The search of designers for novel, alternative solutions, increases the likelihood for developing valuable and creative solutions (Lawson & Loke 1997).

Analogizing in design assists in enriching the search space of ideas and can be perceived as a strategy that contributes to the achievement of a shared understanding among team members to solve the design problem. (e.g. Hey et al., 2008). The utilization of analogies in the formative investigation of different designers is achieved through evaluating the problem from a variety of viewpoints, experimenting with solutions (a solution-focused strategy), learning from the results and repeating this propose-experiment-learn cycle until a satisfactory solution has been reached (Dorst, 2003). In Perkins view of design as a structure adapted to a purpose (Perkins, 1986) there are the four questions that define the nature of any design: (i) what is its purpose (or purposes)? (ii) What is its structure? (iii) What are model cases of it? and (iv) what are the arguments that explain and evaluate it? (Perkins, 1986). These questions provides the perspective that differences design disciplines have different learning and creative processes. For example industrial designers may rely more on concrete experience; graphic designers may rely more on abstract conceptualizations and craft designers may relay more on reflective observations due to the nature of their work. The engineering design process is often iterative, team-based, requiring imagination as well visualization and communication abilities in addition to practical, mathematical and scientific problem-solving skills. Designers who rely on concrete experience for their work are open to new experiences, depend on people contact for gathering information, are intuitive and make feeling based judgments (Barmeyer, 2004; Kolb and Kolb, 2005). Those who rely on abstract conceptualization are logical and analytical in their orientation to a learning situation and seek theories and generalizations (Auyeung and Sands, 1996). Designers oriented towards reflective observation watch and observe all sides of an issue in order to understand its meaning and take time to act. Those who prefer active experimentation are more open to take risks and are practical and application oriented (Barmeyer, 2004; Kolb and Kolb, 2005). We can summarize that there is a gap in research concerning our understanding of analogies across different design contexts. A focused approach to the analogies and creative outcomes of the various design disciplines is needed to identify and leverage the innovative strengths of each discipline. We therefore hypothesize:

H3 (a): There is a difference in formative investigation across different design disciplines.

This in turn led to our next hypothesis.

H3 (b): There is a difference in creative outcomes across different design disciplines.

3. Methodology

3.1. Operationalization and Measures

To test the hypotheses, a scale that measures the influence of formative investigation and creative outcomes on innovative behaviors of individuals from different national cultures and design disciplines was applied. The scale is shown in Table 5. The sample of items from Kleyson and Street (2001) on formative investigation was adapted for the factor 'formative investigation'. A pilot study as a pre-test was conducted to assess construct validity and further purify the scales and to evaluate and improve the quality of the questionnaire prior to full implementation of the survey. The survey used 5-point Likert-type scales for the questionnaire ranging from 1 = never to 5 = always.

3.2. Data Collection Procedure

The revised standardized questionnaire was handed to 300 art and design students from design disciplines of industrial, graphic and craft design at a Midwest University. 250 usable responses were obtained. In this study, White Americans, Asians, Hispanics, Europeans, Africans, Middle Eastern and Mixed races were recruited with White Americans, Asians and Hispanics being the majority sample population. The main methodology applied to the survey data is based on the testing the significance of the differences of responses to the survey questions among design students from different national and design cultures.

3.3. Measurement Validation

Administering the survey to 50 students from various groups who were not studying in any design field assessed predictive validity. These were labeled as "the non-creative group". A set of fit statistics was calculated for the model. These included Chi squared = 131 ($p = 0.000$), Chi-squared/df = 2.10, Comparative fit index (CFI) = .939, Goodness of Fit Index (GFI) = .930, Adjusted Goodness of Fit Index (AGFI) = .883 and Root Mean Square Error of Approximation (RMSEA) = .049. All of these fit indices are within the range for a good fitting model (limits for measurement validation).

3.4. Data Analysis

A regression analysis was initially used to investigate the relationship between the factors of formative investigation and creative outcomes. We next investigated whether there were differences in the formative investigation of different national and design cultures as well as creative outcomes. We were mainly interested in responses to the questions related to the categories of Formative Investigation and Creative Outcome among majority sample population of White Americans, Asians and Hispanic cultures as well as design cultures. In other words, we tested the null hypothesis that the mean of the responses in any of the above-mentioned categories are the same across different national and design cultures. We utilized a one-way ANOVA (analysis of variance) to compare the means of responses among the different groups. In case of significant difference, a table based on the Least Square Means (LS Means) was generated to compare the national cultures of American, Asian and Hispanic pair-wise, since these were the national cultures that were of interest and that were in the majority. The means, standard deviations, and inter-correlations among the research variables are summarized in Table 1-4 below. The following items were tested simultaneously and individually for differences in formative investigation, (a) experiment with new ideas or solutions; (b) ask critical questions to frame a design solution; (c) analyze design problems from a different viewpoint; (d) test out ideas or solutions to meet unmet needs.

4. Results

4.1. Correlation between Formative Investigation and Creative Outcomes across Different National Cultures

It was discovered that Creative Outcomes and Formative Investigation are significant covariates. They both also have a positive coefficient (Beta = 0.86, t= 21.16, p<0.0001 and R²= 0.64) which means they positively affect the outcome (the higher the Formative Investigation, the higher the Creative Outcome. This confirmed the fact that formative investigation is an innovative behavior positively related to creative outcomes.

Table 1: Comparison of Formative Investigation across the Three National Cultures

Ethnicity	Formative Investigation	Significant difference between Asian and Hispanic?	Significant difference between Asian and American?	Significant difference between Hispanic and American?
Asian	3.24	Yes t=-3.01 P=0.003	Yes t=3.02 P=0.002	No t=-0.63 P=0.5
Hispanic	3.84			
White American	3.74			
Anova Test	F= 5.67, p=0.004			

Table 2: Comparison of Creative Outcome across the Three National Cultures

Ethnicity	Creative Outcome	Significant difference between Asian and Hispanic?	Significant difference between Asian and American?	Significant difference between Hispanic and American?
Asian	3.09	Yes T=-2.78 P=0.006	Yes T=-2.91 P=0.004	No T=-0.45 P=0.65
Hispanic	3.68			
White American	3.6			
Anova	F= 5.06, p=0.07			

The formative investigation results (Table 1) show a significant difference across different national cultures (F= 5.67, p=0.004). Further, by looking at the LS Means table and checking the pair-wise comparisons of different national cultures, it was discovered that here is a significant difference in responses between American and Asians (t=3.02 p-value of 0.002). Also, that there is a significant difference in responses between Asians and Hispanics (t=3.01 ,p-value of 0.003).

The results (Table 2) further demonstrate that the mean of responses to the Creative Outcome category is different across different national cultures ($F=5.06$, $p=0.07$). We then look at the LS Means table to find the pairs of national cultures that are significantly different from each other. For example, response of Asian participants to the Creative Outcome section of the survey is significantly different from the responses of Hispanic ($t=2.78$ and $p=0.006$) and Americans ($t=2.91$ and $p=0.004$) participants to the same questions. In conclusion, table 1 and 2 results confirms hypothesis H1a and H1b that there is a significant difference in formative investigation across different national cultures and that the difference in the formative investigation leads to a difference in creative outcomes across different national cultures.

4.2. Difference in Formative Investigation and Creative Outcomes across Different Design Disciplines

The results shown in table 3 demonstrate significant difference across the three different design disciplines confirming that the means of responses to the formative investigation category are not the same across design disciplines ($F=9.82$, $p<0.0001$). Drilling down using a paired comparison test, it is seen that there is a significant difference between the craft design group when compared to either the Graphics or Industrial design groups ($t=4.33$, $p<0.0001$ and $t=2.41$, $p=0.017$ respectively) Table 4 results demonstrate significant difference in creative outcomes category across the design disciplines ($F=11.43$, $p<0.0001$). A paired comparison further reveals that the craft group is again significantly different from the Graphics and Industrial design groups. These results confirm hypothesis H2a and H2b that there is a significant difference in formative investigation across different design disciplines and that the difference in the formative investigation leads to a difference in creative outcomes across different design disciplines.

Table 3: Comparison of Formative Investigation across the Three Design Groups

Design Major	Formative Investigation	Significant difference between Graphic and Industrial?	Significant difference between Graphics and Craft?	Significant difference between Industrial and Craft?
Graphics	3.99	No $t=1.46$ $P=0.14$	Yes $t=4.33$ $P=0.0001$	Yes $t=2.41$ $P=0.017$
Industrial	3.78			
Craft	3.45			
Anova Test	$F=9.82$, $p<0.0001$			

Table 4: Comparison of Creative Outcome across the three Design Majors

Design Major	Creative Outcomes	Significant difference between Graphic and Industrial?	Significant difference between Graphics and Craft?	Significant difference between Industrial and Craft?
Graphics	3.88	No $t=1.30$ $P=0.19$	Yes $t=4.61$ $P=0.001$	Yes $t=2.84$ $P=0.005$
Industrial	3.67			
Craft	3.26			
Anova Test	$F=11.43$, $p<0.0001$			

5. Discussion and Conclusion

This study demonstrates that there are differences in the formative investigation of different cultures and that these differences also lead to differences in creative outcomes. In explaining these results, we apply two frameworks that explain the differences in cultures. These are namely the Spontaneous and Divergent creativity modes by Elliot and Nakata (2013) and the personal behavior of human sensuousness by Hsiao and Chou (2004). From this framework, we explain the differences in the formative investigations of the national and design cultures. For example, the lower means for formative investigation of the Asian designers in comparison to Americans and Hispanics can be explained by the fact that the Asians are more intuitive and therefore may be less disposed to testing and experimenting in some situations. The lower means for formative investigation of the craft design in comparison to industrial and graphic design can be explained by the fact that the craft design discipline leans more towards abstract conceptualization and intuitiveness than concrete experimentation.

The exposition by the data analysis that there are differences in the formative investigation processes of each of these cultures has far-reaching theoretical and managerial implications.

5.1. Research Implications

This study throws light on how differences in analogies of different cultures result in differences in creative outcomes and provides an avenue for further research into these arenas. To our knowledge, few studies have systematically explicated the potential beneficial role of combining differences in the formative investigation of different national and design cultures. We demonstrate that differences in cultures transcend national cultures to include design culture. We further demonstrate that creative outcomes are positively correlated to formative investigations across different national and design cultures. Specifically, we demonstrate that there is a significant difference in formative investigation across these different cultures. From the field of national culture, this study demonstrates that White American, Asian and Hispanic cultures have different cognitive representations in the way they experiment with new ideas or solutions, ask critical questions to frame solution and analyze problems from different viewpoints to meet unmet needs. These findings demonstrate that the cognitive representations of their knowledge are different and this influences the novelty of modifications in these representations, leading to different creativity outcomes. Additionally, by highlighting the variations in analogies of national and design cultures and its influence on creative outcomes, this study has implications for cross-cultural research in the arena of cross-cultural equivalence. Triandis (1985) suggests that cross-cultural comparability can be achieved by establishing compatibility across cultures on key categories of equivalence. Conceptual or functional equivalence means that the concept being tested should be meaningful and understood the same way by the respondents in the cultures being examined.

5.2. Managerial Implications

We believe that examining the relationship between differences in formative investigation as expressions of analogies and the influences on creative outcomes can have important practical ramifications. The first is that the insights of this study are relevant for leveraging diversity for increased competitiveness in the global marketplace. Since formative investigation has been found to be positively related to creative outcomes, the combination of different national and design cultures presents an opportunity to heighten formative investigation and innovative outcomes. Cultures vary in how they present information and are manifested in customary behaviors, assumptions and values, patterns of thinking and communicative styles (Borgman, 1992). Shared common elements of formative investigation can also establish transcultural relations with the potential of enhancing formative investigation and creative outcomes. The consideration of analogies of different cultures presents opportunities for the use of a number of analytical tools drawn from various cultures. Diverse novel associations and linkages can be made which lead to creative outcomes. Visual mental imagery used during formative investigation facilitates the generation, interpretation and manipulation of information through spatial representation (Dahl et al., 1999). Mental imagery also increases the accessibility of related cognitive, emotional, and behavioral representations (Johnson and Sherman, 1990). Finally, the application of the frameworks to explain the differences in formative investigation points to the fact that judgments should not be made on specific cultures as less creative since the analogies are different.

5.3. Limitations and Future Research

Our study focuses on the differences between three main national cultures – American, Asian and Hispanic as well design cultures. In this study the cultures are treated as exclusive. However, Yeo (1996) has pointed out that cultures are not mutually exclusive and individuals may belong simultaneously to multiple cultures, each of them influencing preferences and behavior. Additionally, transculturation occurs when individuals from different cultures interact. Secondly, participants in this study are classified as belonging to specific cultures with not much consideration for acculturations effects. There is the possibility that some of the participants, albeit from other cultures could have become acculturated to the White American culture. However, Participants selected were mostly international students with only a few years stay in the United States and participants were cautioned to select national cultures they identified the most with. Future Research can however control for effects of acculturation from the dominant culture when investigation the innovative behaviors and creative outcomes of national cultures.

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Table 5: Table of Scale Items for Measuring Constructs (Adapted from Kleyson and Street, 2001) Ranking

In your current role as a designer do you often...		N	AN	S	VO	A
S/N	Formative Investigation	1	2	3	4	5
1	Experiment with new ideas or solutions					
2	Ask critical questions to frame a design solution					
3	Analyze design problems from a different viewpoint					
4	Test out ideas or solutions to meet unmet needs					
	Creative Outcomes					
5	Arrive at unexpected outcomes in your designs					
6	Produce novel designs					

Table 6: Frameworks for Cross-Cultural Analogies

**Sensuous Association Model Spontaneous (S) and Divergent (D)
(Hsiao & Chou , 2004) Creativity Modes (Elliot & Nakata, 2013)**

Personal Behaviors of Human Sensuousness	Spontaneous (S) Mode	Divergent (D) Mode
(1) Looking: Information input course.	Adaptiveness Addresses creativity by making small changes, usually in process, in order to solve a problem.	Disruptiveness Addresses creativity by making large leaps to achieve salience from known solutions.
(2) Thinking: Inference and re-association	Intuitiveness Work is done intuitively through use of instinctive yet insightful choices to generate a product that is emotionally profound.	Rationality Work is done through use of a conscious logic (not necessarily linear), making the next most right feasible connection to generate a product with intellectual appeal
(3) Comparing: Extraction and restructuring	Process-Oriented The problem is held constant and the procedure varied, with any errors made in the process utilized to give room for new procedures and resolutions; emphasis is on doing.	Results-Oriented The procedure is held constant and the goals vary to achieve new forms and breakthroughs. The interest is in outcomes that are observably fresh, with an undercurrent of pragmatism to ensure these ends.
(4) Describing: Describe mental mental images formed as creativity input.	Metaphorism A preference for indirectness and symbolism, leading to a product that is figurative or suggestive in nature	Literalism A preference for translating ideas directly into the product such that the product's meaning, utility, or features is apparent