Psychological and Environmental Predictors of Student Imagination: 
The Mediating Role of Generative Cognition

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Abstract
This study aimed to explore what psychological and environmental influences stimulated imagination in education major university students. In addition, it was assessed to what degree these influences had on student imagination. The participants in this study were two groups of students from eight education programs. Sample one \((n = 402)\) served as the calibration sample for testing the most appropriate structures of imaginative capability scale and psychological/environmental influence scales, using exploratory factor analysis. Sample two \((n = 380)\) served as the validation sample using confirmatory factor analysis for validating the factor structure from sample one, and establishing the predictive model. The results of this study supported that imagination consists of nine capabilities, namely crystallization, effectiveness, elaboration, exploration, intuition, novelty, productivity, transformation, and sensibility. The psychological influences regarding imagination stimulation were comprised of six factors, namely: intrinsic motivation, self-efficacy, inspiration through action, stress, emotion, and generative cognition. The environmental influences of imagination-stimulation were composed of four factors, namely: social climate, organizational measure, physical component, and human aggregate. The hypothesis of the study that generative cognition plays a mediating role on imagination-stimulation was partially supported. The structural model also showed that variables of intrinsic motivation, emotion, self-efficacy, and organizational measure have significant, indirect effects on imagination.

Keywords: Environmental influences, Generative cognition, Imagination, Mediating effects, Psychological influences

1. Introduction
Young children see the world in a fresh and vivid way, often having considerable opportunities to choose how to express their ideas. This creates a positive climate for young children to realize their imagination and show their creativity. In addition, pre-school teachers usually use role play, music making, expressive painting, and imaginative movement to promote children’s creativity. Indeed, imagination is one of the most important cognitive capacities for learning in that “it permits us to give credence to alternative realities” (Heath, 2008, p. 115). However, imagination can gradually vanish as people grow up due to various discouraging life experiences. These discouragements can increasingly limit the power of exploration, discovery, and practice.
In response to this phenomenon, many educational programs around the world have been launched. One of the most progressive developments of curriculum in higher education can be found in the activities of the UK Higher Education Academy - Imaginative Curriculum Project. At the heart of this project is a campaign to encourage higher education to give greater attention, to its role in developing student creativity. This initiative has created a network of educational practitioners who believe that designing a curriculum is a creative process in which knowledge, skills, imagination and passion for a subject come together (Hicks, 2007). The Imaginative Curriculum Network is a cross-disciplinary community of people who provide practical help to teachers, who want to develop their curricula in ways that are more likely to foster student imagination and creativity.

Kress (2000) held that curriculum is a design for the future. A curriculum should provide important means and resources for the individual’s transformative action into making themselves socially human. Although earlier studies in the field of education appreciated the value of imagination contributing it to this transformative action (e.g., Heath, 2008; Thomas, 1999), little work has been done pertaining to the variables responsible for imagination, let alone developing an evaluation tool for assessing imagination. Taking these concerns into account, this study aimed to explore what psychological and environmental variables influenced the imagination of education major university students, and the effects these variables had on their imagination. Imagination in this study referred to the process of transforming the inner imagery of education students, when they were faced an instructional design task.

1.1 Imagination

Imagination enables people to go beyond actual experience and construct alternative possibilities, in which a fragmented situation becomes a meaningful whole (Passmore, 1985). Therefore, imagination can be viewed as the basis for cultivating creative thinking, and thus the driving force of innovation (Finke, 1996). From the related literature, nine capabilities were compiled to represent human imagination. These capabilities were crystallization, effectiveness, elaboration, exploration, intuition, novelty, productivity, sensibility, and transformation (Cartwright & Noone, 2006; Folkmann, 2011; Liang, Chang, Chang, & Lin, 2012).

First, imagination connects “abstract properties” and “concrete universals” by the law of association, allowing us to set aside familiar distinctions and definitions (Greene, 2000, p. 3). Vygotsky (2004) also believed that all objects of common life appear as a crystallization of the imagination. Second, every invention is the result of a particular human need, for its own special purpose. Reiner and Gilbert (2000) confirmed that imagination is goal-oriented, based on prior experiential imagery, which needs to be examined by its effectiveness. Third, during the beginning of imagination, an individual’s attention is spontaneous, natural, and effortless. As the process continues, imagination becomes a long, detailed, and laborious personal moment (Ribot, 1906). Cartwright and Noone (2006) explained that imagination is what occurs as a person encounters new ideas and engages in confrontations with arguments and controversies. This is an experience of elaboration.
Fourth, imagination consists of the possibility of creation as a qualitative leap, which allows one to explore, dare, and challenge institutional order, and thus overcome limits (Colello, 2007). Fifth, Reichling (1990) contended that knowledge is gained directly as an insight or a grasp of the whole through intuition. Townsend (2003) anchored that if people utilize more intuitive representations, then their imagination would last longer. Sixth, the Platonic philosophy has associated imagination with novelty, creativity, and irrationality. Vygotsky (2004) also held that although imagination builds using materials supplied by reality, its products arise from using combinations of concepts that are more removed from reality.

Seventh, imagination corresponds to four particular sets of conditions namely: quantity of images; quantity and intensity of images; quantity, intensity and duration of images; as well as complete systematization (Ribot, 1906). All of these evolving conditions are related to physical dimensions of imaginative productivity, continuity and fluency. Eighth, Ribot (1906) held that the essential element of imagination in the intellectual sphere is the capacity of thinking through analogies. The core principle behind analogy is transformation. Vygotsky (1978) stressed that this transformation enables children to learn how to control a situation through the use of symbols. Finally, inventors strive to achieve their goals and overcome problems, often experiencing painful struggles in thoughts, feelings, and emotions during creative activity (Ricoeur, 1978). Reichling (1990) also confirmed that feeling is assigned a cognitive dimension, in terms of imagination. Sensibility is thus identified as another important characteristic of imagination.

In addition, Fettes (2010) in his recent work identified eight functional capabilities of imagination, which included: grasping regularity, grasping detail, grasping composition, grasping wholes, grasping possibility, grasping struggle, grasping indices, and grasping inconsistency. Fettes categorized these imaginative capabilities into three groups. The first three capabilities might be thought of as grasping the coherence and stability of the world; the second three capabilities emphasized change, variation, and unpredictability; and the last group of two emphasized the role of integration.

1.2 Influential variables on imagination stimulation

Research has shown that the environment can facilitate, modify or hinder certain human behaviours and emotions (e.g. Strange & Banning, 2001). Accordingly, the campus environment can be divided into four dimensions: physical component, organizational measure, social climate, and human aggregate (American College Personnel Association, 1994). The physical component dimension of a campus consists of its natural environment (geographic location, topography, temperature, etc.) and man-made environment (architecture, sound, facilities, and messages sent to its inhabitants). Both components define space for activities and events, thereby encouraging some phenomena while limiting others (Strange, 2000). There are numerous follow-up studies which indicate that the environment has a profound impact on students’ imagination (e.g. Büscher, Eriksen, Kristensen, & Mogensen, 2004; Claxton, Edwards, & Scale-Constantinou, 2006).

The organizational measure dimension arises from the myriad decisions made about environmental purposes and functions (Strange, 2000). Who is in charge? How will resources be
distributed? What must be accomplished and how quickly? How will participants be rewarded for their accomplishments? As a result of this need, rules and regulations are formed, rewards systems are developed, and reports become necessary for resource allocation. Such organizational measures could raise or lower the morale of participants. Many studies by modern scholars (e.g. Claxton et al., 2006; Kangas, 2010) also give evidence as to the influence of organizational measures on students’ imagination development.

The social climate dimension focuses on the subjective experiences of participants (Strange et al., 2001). Social climate has both intrinsic influence and external impact. McMillan (1995) thus held that all schools should create a context that is full of encouragement and support in order to cultivate students’ imagination. Moreover, the human aggregate dimension represents the collective characteristics of people who inhabit the environment. This dimension creates features in an environment that reflect varying degrees of consistency, especially in terms of organizational culture, tradition or style (Huebner et al., 1990). Modern research (e.g. Claxton et al., 2006; Treadaway, 2009) also echoes the impacts of socially constructed and human aggregate dimensions on an individual’s imagination.

In addition, human imagination will also be stimulated by psychological sources such as motivation, emotion and cognition (Byrne, 2007). According to Rosenbaum (2002), people’s performance at a given time is influenced by what they imagine and plan to do next. Such anticipatory effects have been treated as clues to the nature of human perceptual-motor planning. Oettingen and Mayer (2002) also indicated that positive expectations would predict high-effort and successful performance. This form of thinking about the future is closely related to motivation.

Fredrickson (2001) suggested that emotions such as joy and love broaden a person’s available repertoire of cognitions, thus enhancing creativity and imagination. Although emotions have been studied as facilitating variables in changing people’s attitude, creativity and problem-solving skills (e.g. Erez & Isen, 2002), there are conflicting studies however, that argue conversely. For example, emotions experienced during learning processing can be viewed as an unnecessary load on working memory, and it can have a negative effect on reasoning (e.g. Paas et al., 2003).

Many studies indicated that individuals with high self-efficacy perceive themselves as capable of taking the necessary steps to resolve problems (e.g. Bandura, 2000). They believe and imagine that they can affect change, and have control over their thoughts and actions. They are confident in their capacities, and consider difficult tasks as challenges rather than threats. In addition, they set meaningful goals and strive to achieve them. In short, people with high self-efficacy are confident and imagine themselves able to do it!

Recent studies in the field of creative imagery revealed the cognitive structures and processes that are involved in creative thinking and imagination (Finke, 1996). For example, in the geneplore model of creative cognition, Finke claimed that two aspects accounted for creative thinking and imagination, a generative phase where an individual formulates mental representations, and an exploratory phase where those structures are adopted to establish creative ideas. Creative thinking at the generative phase is closely associated with generative cognition, while the exploratory phase is associated with meta-cognition. Additionally, O’Connor and Aardema (2005) situated imagination
within consciousness complete with its own pre-cognitive, cognitive and meta-cognitive domains. It allows us to realize how “believed-in imaginings” develop and become under some circumstances, “lived-in experiences.”

The philosophical framework provided by Vygotsky (1978, 2004) includes not only insightful interpretations about the cognitive tools of mediation, but also the re-interpretation of important concepts in psychology such as the notion of internalization of knowledge. Internalization of acquired knowledge and experience is a crucial way to facilitate imagination (Valett, 1983). Many studies supported that cognitive structures and related tools are closely associated with the learner’s perceptions, feelings, motivations and other ways to trigger ideas (e.g. Finke, 1996; Taylor et al., 1998). Thus, generative cognition may play a mediating role in stimulated imagination (Finke, 1996; Folkman, 2011; Vygotsky, 2004). Subsequently, the following relationships were hypothesized in this study:

Hypothesis 1. Generative cognition is positively associated with imagination.

Hypothesis 2. Generative cognition mediates the effect of environmental variables and imagination.

Hypothesis 3. Generative cognition mediates the effect of psychological variables and imagination.

Figure 1 summarizes the three sets of variables examined in the present study and their hypothesized relationships with respect to imagination.

![Figure 1. Hypothesized model of the present study](image)

2. Method

2.1 Measures

**Imaginative Capability Scale.** Based on the research of Liang et al. (2012), the measure for imaginative capability in this study was a 9-item scale. Respondents answered on a five-point scale ranging from 1 = strongly disagree to 5 = strongly agree. Some representative items are: “I am good at seeking improvement by logically analyzing ideas” (Cronbach’s α = .86), “I often help myself imagine by arousing personal feelings” (Cronbach’s α = .81), and “I often have uncommon ideas compared to others” (Cronbach’s α = .83).

**Psychological Influence Scale.** Based on the study done by Hsu, Huang, and Lin (2012), psychological influences were measured with a 24-item scale which was composed of six subscales namely: intrinsic motivation, generative cognition, emotion, stress, inspiration through action, and self-efficacy. The generative cognition is a four-item subscale that measured the degree to which participants considered what cognitive approaches were important in stimulating their imagination.
The emotion subscale includes three items reflecting the extent to which participants reported being positively influenced by a feeling. The stress subscale is a four-item subscale that indicated the degree to which participants felt their imaginations were influenced by their negative psychological states and surroundings. Self-efficacy, a five-item scale, evaluated the extent to which participants reported being influenced by the belief in their own competence. The intrinsic motivation subscale consists of four items that assess participants’ imagination being influenced by personal satisfaction rather than for some external rewards. Finally, four items constitute the inspiration through action subscale and examine how participants felt regarding their imagination being influenced by meta-cognition with hands-on practice. Respondents answered on a five-point scale ranging from 1 = strongly disagree to 5 = strongly agree. Some representative items from this scale are: “Use immersive sensory exploration to spark imagination” (generative cognition, Cronbach’s α .73), “Joyfulness from the surroundings” (emotion, Cronbach’s α .81), “Anxiety felt by individuals” (stress, Cronbach’s α .85), “Be determined to achieve set standards” (self-efficacy, Cronbach’s α .85), “Courage to present different ideas” (intrinsic motivation, Cronbach’s α .84), and “Hands-on design with constantly-changing concepts envisaged in mind” (inspiration through action, Cronbach’s α .81).

Environmental Influence Scale. Based on the study of Liang, Chen, and Huang (2012), environmental influences were measured with a 19-item scale which was composed of four subscales namely: social climate, physical component, organizational measure, and human aggregate. The social climate subscale consists of seven items that assess the extent to which participants reported being influenced by the climate of the class. The physical component subscale includes four items reflecting the degree to which participants felt the facilities and messages in an environment stimulated their imagination. The organizational measure subscale is a five-item subscale that measures participant perception of the influence of organizational structure and instructional measures. Finally, three items constitute the human aggregate subscale. It reflects the extent that the imagination is influenced by the organizational culture and its dominant human characteristics by the participants. Respondents answered on a five-point scale ranging from 1 = strongly disagree to 5 = strongly agree. Some representative items from the survey are: “Communication and discussion with classmates” (social climate, Cronbach’s α .87), “Public spaces for creation, discussion and exhibitions” (physical component, Cronbach’s α .72), “Teacher’s encouragement and praise for taking risks” (organizational measure, Cronbach’s α .83), and “There is a culture on campus of putting imagination into practice” (human aggregate, Cronbach’s α .80).

2.2 Participants, procedure and analyses

The participants in this study were two samples of students from eight education programs across different regions in Taiwan. Sample one (n = 402) served as the calibration sample for testing the appropriate structures of the imaginative capabilities, psychological influence, and environmental influence using exploratory factor analysis. Sample two (n = 380) served as the validation sample using confirmatory factor analysis for validating the factor structure from sample one, and establishing the predictive model. Of the participants of sample one, 250 of 402 were
female (62%). The dominant grade groups were sophomores (29%) and graduate students (29%). In sample two, 286 of 380 were female (75%). The majority of grade group was also sophomores (24%).

In the questionnaire, students were asked to determine the level of agreement with regard to each imaginative capability, and the strength of influence that each item of psychological/environmental influence had on their imagination. Data collection of each survey was conducted by graduate assistants who were accompanied by the class instructor. All the assistants were graduate students in the video/film programs. Each of them received 18-hour training in order to ensure the quality of investigation.

In order to ensure the quality of this study, the research team discussed the survey content with instructors in the target programs first, and then arranged similar assignments and schedules. Therefore, this study could be implemented across campuses under a comparable timetable and similar design tasks. The investigation process delivered in each program followed the same procedure. The participants were guaranteed anonymity, confidentiality, and the right to review the results of their responses.

3. Results

3.1 Principal component analysis and confirmatory factor analysis

Both principal component analysis (PCA) with promax-rotation and confirmatory factor analysis (CFA) with maximum likelihood estimator were conducted to determine the most appropriate structure of the developed scales. The number of factors to be extracted for these analyses was determined using a number of criteria which include: eigenvalues above 1.0 (Kaiser, 1960), examination of Cattell’s scree test (Cattell, 1966), communality values greater than .30, and the total variance accounted for by each factor. Based on these criteria, in the sample one, data was analyzed using SPSS version 17.0 software. The single-factor solution of imagination (explained variables of 33.27%) with an oblique rotation provided a good factor structure both conceptually and statistically. Our results also showed that the internal consistency of imagination (.81) was considered stable.

In the sample two, CFA was performed with LISREL 8.80 to further test the factor structure. We used the indicators recommended by Hu and Bentler (1999) and Tabachnick and Fidell (2001) to assess goodness of model fit: Comparative Fit Index (CFI; .95 or above indicating excellent fit, .90-.95 indicating an acceptable fit), Root-Mean-Square Error of Approximation (RMSEA; .05 or below indicating excellent fit, .05-.08 indicating an acceptable fit), Standardized Root Mean Squared Residual (SRMR; .05 or below indicating excellent fit, .05-.08 indicating an acceptable fit), Tucker-Lewis Index (TLI; .95 or above indicating excellent fit, .90-.95 indicating an acceptable fit). In regards to the imaginative capability, the single-factor solution yielded acceptable fit for this study ($X^2 = 135.89, df = 27, p < .005, CFI = .94, RMSEA = .08, SRMR = .06, TLI = .92$) with a construct reliability of .84 (refer to Table 1).
In regards to psychological influences for the sample one, the PCA extracted six factors with eigenvalues greater than one, explaining 56.49% of the cumulative variances. These six indicators were: intrinsic motivation (M = 4.09, SD = .54), self-efficacy (M = 3.91, SD = .57), stress (M = 3.63, SD = .69), inspiration through action (M = 3.92, SD = .53), emotion (M = 4.06, SD = .61), and generative cognition (M = 3.90, SD = .50). Our results also indicated that the internal consistency of psychological influences (.87) was considered stable.

In the sample two, the results of CFA showed a good fit to match the hypothesis that six psychology-related factors influence imagination, \(X^2(237) = 711.91\); CFI = .97, RMSEA = .07, SRMR = .06, TLI = .96. The factor loadings of items on the subscale of intrinsic motivation ranged from .70 to .77 (with a construct reliability of .82), those of self-efficacy from .69 to .78 (with a construct reliability of .86), those of stress from .62 to .85 (with a construct reliability of .84), those of inspiration through action from .58 to .81 (with a construct reliability of .81), those of emotion from .55 to .91 (with a construct reliability of .82), and those of generative cognition from .53 to .67 (with a construct reliability of .72).

With respect to environmental influences for the sample one, the PCA extracted four factors with eigenvalues greater than one, explaining 50.05% of the cumulative variances. These four indicators were: social climate (M = 4.04, SD = .54), physical component (M = 3.55, SD = .48), organizational measure (M = 3.99, SD = .51), and human aggregate (M = 3.91, SD = .67). Our results also indicated that the internal consistency of environmental influences (.89) was considered stable.

In the sample two, the results of CFA showed a good fit to match the hypothesis that four environment-related factors influence imagination, \(X^2(146)= 514.40\); CFI = .96, RMSEA = .08, SRMR = .06, TLI = .96. The factor loadings of items on the subscale of social climate ranged from .46 to .75 (with a construct reliability of .85), those of physical component from .59 to .63 (with a construct reliability of .71), those of organizational measure from .63 to .76 (with a construct reliability of .82), and those of human aggregate from .67 to .81 (with a construct reliability of .78).

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Item</th>
<th>Sample 1</th>
<th>Sample 2</th>
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<tr>
<td></td>
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<td>M</td>
<td>SD</td>
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<tr>
<td>Productivity</td>
<td>I constantly have ideas toward my designs</td>
<td>3.27</td>
<td>.80</td>
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<tr>
<td>Transformation</td>
<td>I am flexible in my thinking and can transfer ideas to multiple fields of tasks</td>
<td>3.55</td>
<td>.76</td>
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<tr>
<td>Sensibility</td>
<td>I often help myself imagine by arousing personal feelings</td>
<td>3.70</td>
<td>.73</td>
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<tr>
<td>Intuition</td>
<td>I often come up with new ideas leading by my intuition</td>
<td>3.78</td>
<td>.76</td>
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<tr>
<td>Novelty</td>
<td>I often have uncommon ideas compared to others</td>
<td>3.21</td>
<td>.78</td>
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<tr>
<td>Exploration</td>
<td>I like to explore unknown areas of knowledge and experience</td>
<td>3.92</td>
<td>.69</td>
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<tr>
<td>Effectiveness</td>
<td>I often complete my tasks by focusing on effective ideas</td>
<td>3.57</td>
<td>.71</td>
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<tr>
<td>Crystallization</td>
<td>I am good at expressing abstract ideas by using concrete examples</td>
<td>3.50</td>
<td>.81</td>
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<tr>
<td>Elaboration</td>
<td>I improve my thoughts by focusing on formalizing ideas</td>
<td>3.44</td>
<td>.82</td>
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</table>
3.2 Correlations

The relationship between the influential variables and imagination was continually examined. The team found that the averaged correlation coefficient is .28, and the individual coefficients are between .15 and .44. The results also indicated that the influential variables were significantly correlated, $p < 0.05$. The averaged correlation coefficient of the influential variables is .66, and the individual coefficients are between .39 and .87 (refer to Table 2).

Table 2. The correlation among variables ($n = 380$)

<table>
<thead>
<tr>
<th>Variables</th>
<th>1</th>
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<tbody>
<tr>
<td>1. Imagination</td>
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<tr>
<td>2. Intrinsic motivation</td>
<td>0.27$^*$</td>
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<td>3. Self-efficacy</td>
<td>0.25$^*$</td>
<td>0.65$^*$</td>
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<td>4. Stress</td>
<td>0.15$^*$</td>
<td>0.40$^*$</td>
<td>0.53$^*$</td>
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<tr>
<td>5. Inspiration through action</td>
<td>0.29$^*$</td>
<td>0.78$^*$</td>
<td>0.72$^*$</td>
<td>0.39$^*$</td>
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<tr>
<td>6. Emotion</td>
<td>0.25$^*$</td>
<td>0.68$^*$</td>
<td>0.61$^*$</td>
<td>0.39$^*$</td>
<td>0.59$^*$</td>
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<td>7. Generative cognition</td>
<td>0.44$^*$</td>
<td>0.82$^*$</td>
<td>0.68$^*$</td>
<td>0.44$^*$</td>
<td>0.67$^*$</td>
<td>0.69$^*$</td>
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<td>8. Social climate</td>
<td>0.29$^*$</td>
<td>0.71$^*$</td>
<td>0.66$^*$</td>
<td>0.53$^*$</td>
<td>0.66$^*$</td>
<td>0.67$^*$</td>
<td>0.73$^*$</td>
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<td>9. Organizational measure</td>
<td>0.32$^*$</td>
<td>0.72$^*$</td>
<td>0.61$^*$</td>
<td>0.44$^*$</td>
<td>0.64$^*$</td>
<td>0.57$^*$</td>
<td>0.73$^*$</td>
<td>0.87$^*$</td>
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<td>10. Human aggregate</td>
<td>0.23$^*$</td>
<td>0.68$^*$</td>
<td>0.68$^*$</td>
<td>0.50$^*$</td>
<td>0.64$^*$</td>
<td>0.57$^*$</td>
<td>0.65$^*$</td>
<td>0.74$^*$</td>
<td>0.73$^*$</td>
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<tr>
<td>11. Physical component</td>
<td>0.27$^*$</td>
<td>0.66$^*$</td>
<td>0.63$^*$</td>
<td>0.47$^*$</td>
<td>0.57$^*$</td>
<td>0.54$^*$</td>
<td>0.67$^*$</td>
<td>0.72$^*$</td>
<td>0.77$^*$</td>
<td>0.68$^*$</td>
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*p < .05.

3.3 Structural model and hypothesis testing

The present hypotheses suggest that three sets of variables (generative cognition, environmental variables, and psychological variables) influence imagination, and that generative cognition mediates the effects of the other two clusters of variables on imagination. According to these hypotheses, the research team using data of the sample two, first proposed a full mediation model. In this model, all the variables would enhance generative cognition, and generative cognition, in turn, would fully mediate the influence of these variables on imagination. We also wanted to compare the full mediation model with a model that is more consistent with the idea that some of the variables may continue to enhance imagination after controlling for the influence that such effects have on generative cognition. Therefore, in the partial mediation model, we predicted that all the influential variables would have both direct and indirect effects on the student imagination (refer to Figure 2).
Figure 2. The full mediation model (left) and partial mediation model (right) in the present study.

Note: Environmental influences: social climate (sc), physical component (pc), organizational measure (om), human aggregate (ha); psychological influences: intrinsic motivation (im), stress (st), self-efficacy (se), inspiration through action (ic), and emotion (em).

Both of the full mediation model ($\chi^2 = 2679.55$, $df = 1228$, CFI = .97, RMSEA = .06, SRMR = .06, TLI = .97) and partial mediation model ($\chi^2 = 2671.17$, $df = 1219$, CFI = .96, RMSEA = .06, SRMR = .05, TLI = .96) showed a good fit to the present data. The chi-square difference test between these two models showed no significance. Since the full mediation model is more simplified and more presentable, the team decided to adapt it and continually made necessary modifications.

In the full mediation model, however, due to a high correlation between some of the variables, neither all were significantly associated with imagination. Taking into account the multicollinearity and the low standardized path coefficients, the less significant paths were removed. In the revised model, only the four paths respectively, organizational measure, intrinsic motivation, emotion, and self-efficacy to the mediator (generative cognition) were kept.

This revised model showed a model fit comparable to that of the initial model, $\chi^2 = 922.70$, $df = 394$, CFI = .96, RMSEA = .06, SRMR = .06, TLI = .96. Furthermore, it accounted for substantial variance in both generative cognition ($R^2 = .73$) and imagination ($R^2 = .17$). The standardized path coefficient of generative cognition reached .41*, and the path of intrinsic motivation reached .40*, followed by the path of organizational measure .25*, emotion .17*, and self-efficacy .16*. In the case of model trimming, a significant chi-squared goodness of fit test ($\Delta\chi^2 = 1756.85$, $\Delta df = 834$, $p < 0.05$) suggests that the revised model is a more suitable fit to the data than the initial, full mediation.
model, and hence, should be supported.

Overall, the SEM results summarized in Figure 3 support the present hypotheses. *Generative cognition* directly influenced imagination (Hypothesis 1 was supported). Partially supporting the mediating hypotheses (Hypothesis 2 and 3), one environmental variable (*organizational measure*) and three psychological variables (*intrinsic motivation, emotion, and self-efficacy*) influenced imagination through their impacts on generative cognition.

![Structural model depicting cognitive generation as mediator of influential variables and imagination.](image)

4. Discussion

This study examined what psychological and environmental variables influence the imagination of education students. In addition, it was assessed to what degree these influences had on student imagination. While philosophical studies abound on the influence of diverse variables on imagination-stimulation, little articulates about imaginative capabilities, nor the variables that may mediate this relationship. Given this observed gap in the literature, the results of this study increase the understanding of the indirect paths from psychological and environmental variables to imagination. The present study especially contributes to the understanding of *generative cognition* as mechanisms through which psychological and environmental states might affect our student imagination.

The results of this study supported that human imagination consists of the nine capabilities: productivity, transformation, sensibility, intuition, novelty, exploration, effectiveness, crystallization, and elaboration. In no way definitive or exhaustive, nonetheless, it has yielded a path for further inquiries. One consideration to bear in mind is whether these imaginative capabilities can be categorized as being easier to be manipulated? This emerged consideration is based upon Betts’s (1916) belief that any activity of human imagination can be classified into reproductive imagination and creative imagination. In other words, how can these capabilities to be
grouped into these two categories? What psychological and environmental variables, in turn, have more or less effects on these two types of imagination respectively, and how do they work? On the basis of the definition of these two categories, the authors would propose two hypotheses for testing. First, the capabilities of novelty, productivity, sensibility, intuition and exploration could be categorized as creative imagination. Second, effectiveness, elaboration, crystallization and transformation could be categorized as reproductive imagination. All of these interesting issues and proposed hypotheses grant further research.

Despite numerous studies of meta-cognition and stress influencing human cognition (e.g., O’Connor et al., 2005; Paas et al., 2003), these variables did not play significant roles to predict generative cognition in the present study. In other words, the effects of these two variables were less than the effects yielded from other variables such as intrinsic motivation, self-efficacy, and emotion. This result may suggest that interesting tasks, free discussions and joyfulness from the surroundings should be embedded in learning activities in order to trigger the student imagination. This also suggests that strengthening student self-confidence and work-related efficacy may facilitate his or her imagination.

According to our findings, the environmental influences on imagination are composed of four variables, namely social climate, organizational measure, human aggregate, and physical component. Of interest, only organizational measure was a significant predictor of generative cognition. This suggests the possibility that the effect of organizational measures with respect to a person’s cognitive approaches is greater than the effects of other environmental variables. This interpretation corresponds to the research regarding imagination-stimulation through instructional strategies and rewards systems (Claxton et al., 2006; Kangas, 2010). Thus, to improve the student imagination, it may be important to widen teacher capacity of tolerance and diversify his or her ways of encouragement.

Although our results supported the mediating role of generative cognition in the current study, we wonder if any other mediator, or if any moderator exists? Are there any non-linear relationships existing among the variables discussed in the present study? Much work needs to be done in order to shed light on these issues. In addition, the structural model showed that organizational measure, intrinsic motivation, emotion, and self-efficacy have indirect effects on imagination. In other words, no amount of organizational measures, driving motives and self confidence will stimulate learners’ imagination, unless students use their cognitive tools. This model implies that researchers and instructors may need to focus less on the indirect and insignificant effects, and more on understanding the direct effects of cognitive tools.

In drawing these conclusions, it is necessary to acknowledge the limitations of this study. First, the final model fits the data well, but the predictive validity could be stronger. This result may be due to the high correlations between some of the variables. Another inference similar to multiple influential variables on human creativity (Shalley, Zhou, and Oldham, 2004), is that both psychological and environmental influences are only but two variables stimulating student imagination. Additional variables, such as learner personality and cultural diversity, should be taken into account for further inquiry. A second limitation is the use of self-reported influence rather than
relying on expert evaluations or behavioral measures. The choice to use self-reports however, was justified by the preliminary nature of the study. There was a lack of existing measures and the questions asked in our study did not include sensitive items that may cause respondents to present themselves in a socially acceptable manner.

Although the limitations of this study must be kept in mind, the results reported here provide intriguing insights into the complexities of imagination-stimulation. The model proposed in this study is significant to the education profession, even to other diverse domains. For example, it would be interesting to elaborate each of the ten imaginative capabilities identified in this study and clarify their uses. It would also be valuable to explore which imaginative capability may be best facilitated in which age-range. It would be even more exciting to elucidate which imaginative capabilities may be required in various domains, e.g., arts, science, design, engineering, or management. Preliminary work such as this always raises a battery of issues and questions. Nevertheless, a great deal of research needs to be further conducted in this area. We sincerely invite you to use the results of this study as a foundation to develop meaningful research projects. We also wish that the utilization of this study will in turn, inspire the construction of appropriate instructional strategies to assist students and develop their imagination.

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