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喚動想像：學習環境與個人心理的效果

Awaken Imagination: Effects of Learning Environment and Individual Psychology

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【摘要 Abstract】

本研究旨在探討，何種學習環境與個人心理變項能促發大學生的想像，以及這些變項的影響效果。研究結果顯示，人類想像可分

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為九個能力指標，影響想像的學習環境有四個變項，影響想像的個人心理有六個變項。本研究假設「生產性認知」可做為學習環境與個人心理預測大學生想像的中介變項，此一假設獲得統計分析的部份支持。本研究所建立的結構方程模型顯示：學習環境之「組織措施」，以及個人心理之「做中悟」和「內在動機」，透過「生產性認知」的中介，均會對大學生想像產生顯著的間接效果。

This study aims to explore what environmental and psychological variables influence the imagination of university students, and the effects of these variables had on imagination. The results of our study supported that the imagination consists of nine capabilities; environmental influences on imagination are composed of four variables; and psychological influences on imagination comprise six variables. The hypothesis of the present study that generative cognition mediates the effects of the other variables on imagination was partially supported. The structural model also showed that the variables of *inspiration through action, intrinsic motivation*, and *organizational measure* have significant, indirect effects on imagination.

[關鍵字 Keywords]

中介效果；個人心理；想像力；學習環境

Mediating effects; Individual psychology; Imagination; Learning environments

I. Introduction

As educational technologists, we construct activities, build systems, and anticipate conversations and actions that will steer learner inquiries towards fulfillment, thus fostering their growth in attaining desirable skills and achieving understanding. Constructing such meaningful experiences not only requires a significant amount of expertise, but also creativity and imagination. According to Goodyear and Retalis (2010), it involves imagining how our learners learn, how they respond to a task, where they work, with whom, how, using what resources, under what circumstance, and over what timescale. Furthermore, we need technological imagination to forecast emerging technologies and their potential applications. We are educational experience

builders under a variety of hats: technician, classroom teacher, specialist, administrator, corporate educator, district curriculum specialist, etc. (Davidson, 2003), and all of these hats require imagination.

Instructional design, by its nature of iterativeness, rarely comes right at the first attempt. It always involves ill-structured rather than well-formed problems (e.g., Ertmer et al., 2008; Jonassen, 2008). Therefore, Roschelle and Jackiw (2000) contended that designing educational experiences is an imaginative art. However, until now, few studies have clearly discussed imagination in the field of educational technology, let alone designed an imagination-based curriculum for the field, or even developed an evaluation tool for assessing imagination. Taking these concerns into account, this study aims to explore what environmental and psychological variables influence the imagination of educational technology students, and the effects of these variables had on imagination. In this study, imagination refers generally to the process of transforming the inner imagery of educational technology students when they face an instructional design task.

II. Literature Review

1. Imagination and the Influential Variables

Imagination is "a creative faculty of the mind" or "a power of the mind," which enables people to go beyond actual experience and construct alternative possibilities in which a fragmented situation becomes a meaningful whole (Passmore, 1985; Perdue, 2003). Therefore, imagination can be viewed as the basis for cultivating creative thinking, and thus the driving force of innovation (Finke, 1996). According to Liang, Chang, Chang, and Lin (2012), nine capabilities were compiled to represent human imagination. These capabilities are crystallization, effectiveness, elaboration, exploration, intuition, novelty, productivity, sensibility, and transformation.

Crystallization refers to an individual's ability to express abstract ideas by using concrete examples (e.g., Vygotsky, 2004). *Effectiveness* refers to an individual's ability to generate effective ideas about the goal (e.g., Gilbert & Reiner, 2000). *Elaboration* refers to seek improvement by formalizing

ideas (e.g., Cartwright & Noone, 2006). *Exploration* refers to an individual's ability to explore the unknown (e.g., Colello, 2007; Valett, 1983). *Intuition* refers to an individual's ability to generate immediate associations to the goal (e.g., Townsend, 2003). *Novelty* refers to an individual's ability to create uncommon ideas (e.g., Vygotsky, 2004). *Productivity* refers to an individual's ability to productively generate ideas (e.g., Folkmann, 2010). *Sensibility* refers to an individual's ability to evoke feelings during the creative process (e.g., Gajdamaschko, 2005). *Transformation* refers to an individual's ability to perform tasks by transforming what they know across multiple fields of knowledge (e.g., Vygotsky, 1978).

Research has shown that the environment can facilitate, modify, or hinder certain human behaviors and emotions (e.g., Komives & Woodard, 2003, p. 302). The campus environment can be divided into four dimensions: physical component, organizational measure, social climate, and human aggregate (American College Personnel Association, 1994). According to Liang, Hsu, Huang, and Chen (2012), the *physical component* dimension reflects the degree to which participants felt the spaces and facilities in an environment stimulated their imagination (e.g., Strange, 2000). The *organizational measure* dimension measures participant perception of the influence of organizational structure and instructional measures (e.g., Brabander, Rozendaal, & Martens, 2009). The *social climate* dimension reflects the extent to which participants reported being influenced by the climate of the class (e.g., Allodi, 2010). The *human aggregate* dimension assesses the extent that the imagination is influenced by the organizational culture and its dominant human characteristics by the participants (e.g., Komives & Woodard, 2003, p. 302).

Human imagination will be stimulated by several psychological sources such as motivation, emotion, cognition, self-efficacy (Hsu, Liang, Chang, & Lin, in press). *Generative cognition* measures the degree to which participants considered what cognitive approaches were important in stimulating their imagination (e.g., O'Connor & Aardema, 2005). *Intrinsic motivation* assesses participants' imagination being influenced by personal satisfaction rather than for some external rewards (e.g., Prabhu, Sutton, & Sauser, 2008). *Emotion* reflects the extent to which participants reported their imagination being influenced by a positive feeling (e.g., Isen & Reeve, 2005). *Stress* indicates the degree to which participants felt

their imagination was influenced by the negative emotional states (e.g., Paas, Renkl, & Sweller, 2003). *Inspiration through action* examines how participants felt regarding their imagination being influenced by meta-cognition with hands-on practice (e.g., Fredrick, 2007). *Self-efficacy* evaluates the extent to which participants reported being influenced by a belief in their own competence (e.g., Bandura, 2012).

2. Hypotheses

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, Pham, Rivkin, & Armor, 1998). Thus, generative cognition can play a mediating role in stimulated imagination. Subsequently, the following relationships were hypothesized in this study:

Hypothesis 1. Generative cognition is positively associated with imagination.

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

Hypothesis 3. Generative cognition mediates the effects 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.

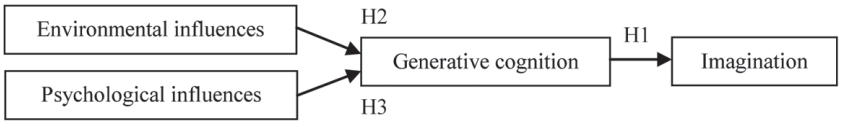

Figure 1: Hypothesized framework of the present study

III. Method

1. Participants and Procedure

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

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. Participation was voluntary but participants received extra points from their instructors.

2. Measures

In the current study, the measurement of imagination was based on the imgination indicators proposed by Liang, Chang, et al. (2012). The participants were asked to determine the level of agreement with regard to each imgination indicator. The items were scored on a five-point Likert scale ranging from 1 = strongly disagree to 5 = strongly agree. The representative items for imaginative capability are "I constantly have ideas toward my designs" (refers to *productivity*, Cronbach's α = .82), "I improve my thoughts by focusing on formalizing ideas" (refers to *elaboration*, Cronbach's α = .85), and "I often have uncommon ideas compared to others" (refers to *novelty*, Cronbach's α = .83).

The measurement of environmental influence was based on the scale used in the study of Liang, Hsu, Huang, et al. (2012). The participants were

asked to determine the strength of influence that each item had on their imagination. Representative items are "Public spaces for creation, discussion and exhibitions" (refers to *physical component*, Cronbach's α = .79), "Teacher's encouragement and praise for taking risk" (refers to *organizational measure*, Cronbach's α = .82), "Communication and discussion with classmates" (refers to *social climate*, Cronbach's α = .87), and "There is a culture on campus of putting imagination into practice" (refers to *human aggregate*, Cronbach's α = .89).

The measurement of psychological influence was based on the scale employed in the study of Hsu et al. (in press). The participants were also asked to determine the strength of influence that each item had on their imagination. Representative items are "Courage to present different ideas" (refers to *intrinsic motivation*, Cronbach's α = .84), "Use immersive sensory exploration to spark imagination" (refers to *generative cognition*, Cronbach's α = .73), "Joyfulness from the surroundings" (refers to *emotion*, Cronbach's α = .81), "Hands-on design with constantly-changing concepts envisaged in mind" (refers to *inspiration through action*, Cronbach's α = .81), and "Be determined to achieve set standards" (refers to *self-efficacy*, Cronbach's α = .85).

IV. Results

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 scales. In the sample one, PCA was performed with SPSS version 17.0 software. The single-factor solution of *imagination* (explained variables of 37.11%) with an oblique rotation provided a good factor structure both conceptually and statistically. Our results also showed that the internal consistency of imagination (.83) was considered stable. In the sample two, CFA was performed with LISREL 8.80 to further test the factor structure. As the result, a single-factor solution yielded acceptable fit for this study (X^2 = 146.01; df = 27; p < .005; CFI = .92; RMSEA = .08; SRMR = .06; TLI = .90) with a construct reliability of .81 (refer to Table 1).

Table 1: Descriptive Statistics and Factor Loading of the Imagination

Characteristic / Item	Sample 1			Sample 2
	M	*SD*	PCA	CFA
Productivity / I constantly have ideas toward my designs.	3.38	.83	.74	.73
Sensibility / I often help myself imagine by arousing personal feelings.	3.69	.78	.72	.64
Intuition / I often come up with new ideas leading by my intuition.	3.72	.76	.67	.61
Transformation / I am flexible in my thinking and can transfer ideas to multiple fields of tasks.	3.49	.75	.63	.66
Novelty / I often have uncommon ideas compared to others.	3.34	.81	.63	.59
Exploration / I like to explore unknown areas of knowledge and experience.	3.91	.72	.60	.56
Crystallization / I am good at expressing abstract ideas by using concrete examples.	3.42	.83	.57	.45
Effectiveness / I often complete my tasks by focusing on effective ideas.	3.54	.71	.46	.50
Elaboration / I improve my thoughts by focusing on formalizing ideas.	3.46	.80	.38	.36

With respect to *environmental influences* for the sample one, the PCA extracted four factors with eigenvalues greater than one, explaining 49.44% of the cumulative variances. These four indicators were: social climate, physical component, organizational measure, and human aggregate. *Social climate*, a seven-item scale (M = 4.09; SD = .51), assessed the extent of which participants reported being influenced by the climate of the class. *Physical component*, a four-item scale (M = 3.91; SD = .52), measured the degree to which participants felt the facilities and messages in an environment would stimulate imagination. *Organizational measure*, a five-item scale (M = 4.01; SD = .53), measured participants' perceptions of the influence from the organizational structure and instructional measures. *Human aggregate*, a three-item scale (M = 3.94; SD = .64), indicated the degree to which participants felt that their imagination was influenced by the organizational culture and its

dominant human characteristics. Our results also indicated that the internal consistency of environmental influences (.92) was considered stable.

In the sample two, the results of CFA showed a good fit to match the hypothesis that four environmental variables influence imagination, $X^2(183) = 673.62$, CFI = .96, RMSEA = .08, SRMR = .06, and TLI = .96. The factor loadings of items on the subscale of *social climate* ranged from .55 to .80 (with a construct reliability of .87), those of *physical component* from .52 to .77 (with a construct reliability of .79), those of *organizational measure* from .62 to .70 (with a construct reliability of .82), and those of *human aggregate* from .67 to .81 (with a construct reliability of .89).

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, self-efficacy, stress, inspiration through action, emotion, and generative cognition. *Intrinsic motivation*, a four-item scale (M = 4.09; SD = .54), assessed participants' imagination being influenced by personal satisfaction rather than for some external rewards. *Self-efficacy*, a five-item scale (M = 3.91; SD = .57), evaluated the extent of which participants reported being influenced by the belief in their own competence. *Stress*, a four-item scale (M = 3.63; SD = .69), indicated the degree to which participants felt that their imagination was influenced by one's negative psychological state and the surroundings. *Inspiration through action*, a four-item scale (M = 3.92; SD = .53), examined how participants felt regarding their imagination being influenced by meta-thinking with hands-on practice. *Emotion*, a three-item scale (M = 4.06; SD = .61), measured the extent to which participants reported being influenced by a positive feeling. *Generative cognition*, a four-item scale (M = 3.90; SD = .50), measured the degree to which participants considered what cognitive approaches were important in stimulating their imagination. Our results also indicated that the internal consistency of psychological influences (.93) was considered stable.

In the sample two, the results of CFA showed a good fit to match the hypothesis that six psychological variables influence imagination, $X^2(237) = 643.48$, CFI = .98, RMSEA = .07, SRMR = .06, and TLI = .97. The factor loadings of items on the subscale of *intrinsic motivation* ranged from .75 to .86 (with a construct reliability of .87), those of *self-efficacy* from .68 to .79 (with

a construct reliability of .86), those of *stress* from .72 to .83 (with a construct reliability of .85), those of *inspiration through action* from .68 to .79 (with a construct reliability of .84), those of *emotion* from .57 to .89 (with a construct reliability of .81), and those of *generative cognition* from .57 to .74 (with a construct reliability of .76).

2. Correlations

The relationship between the influential variables and imagination was continually examined. We found that the averaged correlation coefficient is .33, and the individual coefficients are between .20 and .46. The results also indicated that the ten influential variables were significantly correlated, $p < .05$ (refer to Table 2).

3. Hypothesized Models and Model Testing

According to the proposed hypotheses, we first proposed a *full mediation* model. In this model, all the variables would enhance *generative cognition*, and 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

Table 2: The Correlation among Variables

	Variables	1	2	3	4	5	6	7	8	9	10	11
1.	Imagination	--										
2.	Social climate	.33*	--									
3.	Physical	.30*	.70*	--								
4.	Organizational	.34*	.89*	.64*	--							
5.	Human aggregate	.30*	.79*	.55*	.76*	--						
6.	Intrinsic motivation	.39*	.72*	.55*	.71*	.65*	--					
7.	Stress	.20*	.50*	.38*	.37*	.42*	.43*	--				
8.	Self-efficacy	.32*	.68*	.54*	.63*	.62*	.75*	.69*	--			
9.	Inspiration through action	.40*	.68*	.62*	.63*	.60*	.76*	.64*	.78*	--		
10.	Emotion	.31*	.74*	.53*	.67*	.65*	.72*	.49*	.69*	.64*	--	
11.	Generative cognition	.46*	.72*	.66*	.74*	.64*	.83*	.42*	.69*	.86*	.66*	--

* $p < .05$.

more consistent with the idea that some of the factors 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 both environmental and psychological variables would have direct and indirect effects on student imagination.

Both of the full mediation model (X^2 = 2,893.39; *df* = 1,331; CFI = .97; RMSEA = .05; SRMR = .06; TLI = .97) and partial mediation model (X^2 = 2,893.39; *df* = 1,322; CFI = .97; RMSEA = .05; SRMR = .06; TLI = .97) 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 initial, 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 of *social climate, physical component, human aggregate*, *stress*, *self-efficacy*, and *emotion*, we removed the non-significant paths. In the revised model, only the following three paths were kept, i.e., *organizational measure, intrinsic motivation*, and *inspiration through action* to imagination.

This revised model showed a model fit comparable to that of the initial model, $X^2(317) = 858.18$; CFI = .96; RMSEA = .06; SRMR = .07; TLI = .96. Furthermore, it accounted for substantial variance in both *generative cognition* (R^2 = .84) and *imagination* (R^2 = .21). The standardized path coefficient of *generative cognition* reached .46*, and the path of *inspiration through action* reached .49*, followed *intrinsic motivation* .32* and *organizational measure* .20*. In the case of model trimming, a significant chi-squared goodness of fit test ($\Delta\chi^2$ = 2,051.28; Δdf = 1,014; $p < .05$) suggests that the revised model is a more suitable fit to the data than the initial one, and hence, should be supported. Figure 2 illustrates this final model and estimates of its parameters. The figures displayed along the paths represent standardized path coefficients.

Overall, the SEM results support the present hypotheses. *Generative cognition* directly influenced imagination (Hypothesis 1 was supported). Partially confirming the mediating hypotheses (Hypotheses 2 and 3), one environmental variable (*organizational measure*) and two psychological

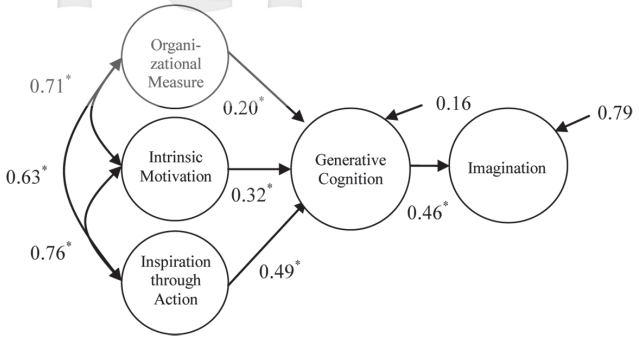

Figure 2: Structural model depicting generative cognition as mediator of influential factors and imagination

* $p < .05$.

variables (*intrinsic motivation* and *inspiration through action*) influenced imagination through their impacts on generative cognition.

V. Discussion

1. Imaginative Capabilities

Our results supported that imagination consists of nine capabilities. However, we ask ourselves, are there any other capabilities together with the present ones which can signify imagination thoroughly? According to the recent studies (e.g., Cartwright & Noone, 2006; Folkmann, 2010), the research team would propose that *elaboration* could be divided into two independent indicators for further study, namely dialectics and focusing. In addition, we bear Betts's (1916) claim in mind that, any activity of human imagination can be classified into reproductive imagination and creative imagination. Other questions would be whether these capabilities can be categorized as being easier to manipulate, or how these capabilities can be grouped into these two categories? According to the definitions, we further propose the following theoretical construct of imaginative capabilities: creative imagination is composed of capabilities of novelty, productivity, sensibility, intuition, focusing, and exploration; and reproductive imagination comprises capabilities of effectiveness, dialectics, crystallization, and transformation.

2. Environmental and Psychological Influences

Accordingly, with respect to the environmental influences, *social climate* was claimed by the participants to have the greatest effect on student imagination, followed by *organizational measure*, *human aggregate*, and *physical component*. In regards to psychological influences, *intrinsic motivation* was claimed to have the greatest effect on imagination, followed by emotion, *self-efficacy*, and *inspiration through action*. These results suggest that soft mechanisms such as welcoming climate, interesting topics, and practical experiences are the powerful stimuli to trigger imagination. Hard factors such as institutional measures, intangible factors such as tradition or culture, and physical factors such as facilities or messages, have also proved themselves to be effective incentives.

In more detail, items with high means such as discussions with classmates associated to *social climate* provided additional support for earlier inquiries on this topic (e.g., McMillan, 1995). High-mean items of *intrinsic motivation* such as interesting assignments and freedom during the design process highlight the importance of positive expectation determined in previous studies (e.g., Oettingen & Mayer, 2002). In respect to *inspiration through action*, high-mean items like "hands-on design with constantly-changing concepts envisaged in mind" underlined the role of meta-thinking (e.g., Fredrick, 2007) which is especially crucial in the practice-oriented profession like educational technology.

Stress, which takes account of task difficulty, competitive pressure, and anxiety bearing, was not originally identified as an independent stimulus in the literature. It would be interesting to discover how this variable is related to *emotion* and, if possible, how to pair them together, or even with other variables, to form specific instructional strategies. Moreover, according to the recent studies in learning environments (e.g., Gislason, 2010; Kember, Ho, & Hong, 2010), student learning should be separated as an independent variable to be studied. This notion, therefore, casts light on the direction of scale revision.

As with many aspects of social science, the magnitude of the correlations obtained from predictive validity studies is usually not high (Cronbach & Meehl, 1955), thus lending support to this study. We found, however, within these influential variables, some of the correlations are noticeably high, i.e.,

social climate vs. *organizational measure*, *inspiration through action* vs. *self-efficacy*, *generative cognition* vs. *intrinsic motivation*, and *generative cognition* vs. *inspiration through action*. Hi-correlation could possibly cause hi-multicollinearity, and hence, may result in the parameter estimation being unstable. These results may imply that the items in the scale may be overlapped which need to be modified further.

Taking together, we propose two additional theoretical constructs for future research. First, the environmental influence on student imagination can include five variables, namely physical component, learning resources, organizational measure, social climate, and human aggregate. Second, the psychological influence on student imagination can include six variables, namely intrinsic motivation, emotion (or positive emotion), stress (negative emotion), generative cognition, inspiration through action, and self-efficacy. These two constructs are also productive enough to warrant further inquires.

3. Mediational Effects

The hypothesis of the present study that *generative cognition* mediates the effects of the other variables on imagination was partially supported. Respecting this, we first proposed two models, one as full mediation and the other as partial mediation. Since the partial mediation model was considered too complicated and its model fit was less suitable than the other one, the full mediation model was adapted for further improvement. In the process of model trimming, we removed the less significant paths, and only kept three indirect effects (the variables of *organizational*, *intrinsic motivation*, and *inspiration through action* to *imagination*) in the revised model. A significant chi-squared goodness of fit test suggests that the revised model is more suitable to the present data than the original one, and therefore should be supported.

Although the mediating role of *generative cognition* was partially supported in this study, we wonder if any other mediator, or if any moderator exists? The key premise of Vygotskian psychology "cultural mediation" (Vygotsky, 2004) inspired us, despite the fact that the culture-related variable such as *human aggregate* in this study seemed to play a statistically insignificant mediation role. Much work needs to be done in order to disclose this issue of mediation.

The structural model also showed that the variables of *inspiration through action*, *intrinsic motivation*, and *organizational measure* have indirect effects on imagination. In other words, no amount of hands-on practices, driving motives, and organizational measures will stimulate learners' imagination, unless they 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.

4. Limitations

Although the present study extends the findings of previous research, it is not without certain limitations. 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, & Oldham, 2004), is that both environmental and psychological influences are but two dimensions stimulating learners' imagination. Additional dimensions, such as learner personality and cultural diversity, should be taken in account for the further inquiry. Second, all the participants were recruited from students in the educational technology field in Taiwan; this sample cannot be considered as a random sample, and would not be a representative sample in other countries. A third 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 this study. There is 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.

VI. Conclusion

The present study supported that imagination consists of nine capabilities, namely crystallization, effectiveness, elaboration, exploration, intuition, novelty, productivity, transformation, and sensibility. The psychological influences regarding imagination comprised six variables, namely intrinsic motivation, self-efficacy, stress, inspiration through action, emotion, and generative cognition. The environmental influences of imagination were

composed of four variables, namely social climate, organizational measure, physical component, and human aggregate. The hypothesis of this study that *generative cognition* mediates the effects of the other variables on imagination was partially supported. The structural model also showed that the variables of *inspiration through action*, *intrinsic motivation*, and *organizational measure* have significant, indirect effects on imagination.

The results reported here provide intriguing insights into the complexities of imagination. The model proposed in this study is significant to the profession of educational technology. 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 welcome interested educators to use our study as a foundation to further develop meaningful research projects and to design appropriate instructional strategies to inspire our students' passion for excellence, nurture their curiosity, develop their imagination, empower their professional life, and awaken their spirit for an unknown future.

VII. Epilogue

The research team recently (October 2012) completed two studies by expanding the imagination index (Liang, Hsu, Chang, & Lin, 2012) to become an Imaginative Capability Scale (ICS). The team then established the reliability, validity, and factor structure of the ICS. This 29-item scale was scored on a six-point Likert scale ranging from 1 = strongly disagree to 6 = strongly agree.

The study 1 conducted an exploratory factor analysis to determine the appropriate structure of the ICS in a sample of 547 college students (serving the calibration sample). A Principal Axis Factoring (PAF) analysis with promax rotation was conducted to determine the dimensionality of the ICS. A three-factor solution (eigenvalues greater than one), with explained variables of 50%, provided the best factor structure. This solution contains three types of imaginative capabilities, namely initiative imagination, conceived imagination, and transformative imagination. *Initiative Imagination* is related to the characteristics of novelty, productivity, and exploration. *Conceived Imagination* is associated to the characteristics of sensibility, intuition,

focusing, effectiveness, and dialectics. *Transformative Imagination* contains the characteristics of crystallization and transformation.

The correlation coefficients between the three factors ranged from 0.602 to 0.706. The Cronbach's α value of Factor 1 (initiative imagination) was 0.918; that of Factor 2 (conceived imagination) was 0.880; and that of Factor 3 (transformative imagination) was 0.896. The hi-value of internal consistency showed that the developed scale had appropriate reliability estimates. The

Table 3: The PAF, *M*, and *SD* of the Study 1

Factor / Item	Loading	*M*	*SD*
Initiative Imagination			
I often have unique ideas compared to others.	.937	4.14	0.919
I can develop ideas from examining different perspectives.	.910	4.12	0.877
I often try untraditional approaches in the project.	.931	4.05	0.952
I often have a rich diversity of ideas.	.827	4.06	0.938
I often use a variety of ways to express ideas.	.683	4.05	0.953
I can constantly come up with various ways to do the project.	.753	3.79	0.943
I often challenge the existing ideas.	.535	3.89	1.012
I often analyze numerous possibilities on how the problem may develop.	.435	4.06	0.972
I like to explore the unknown through a variety of experiences.	.464	4.02	0.978
Conceived Imagination			
I am often emotionally involved in the project.	.408	3.82	1.071
I can quickly sort out complicated messages.	.395	3.87	0.879
I can quickly grasp the big picture.	.385	3.85	0.918
I know how to concentrate on imagination and prevent myself from distraction.	.807	3.81	1.094
I can continue to focus on the project until the ideas formed.	.934	3.77	1.049
I often invest prolonged time on the project until the resolution found.	.862	3.97	1.084
I can come up with the practice which meets the requirements.	.403	4.24	0.697

Table 3: The PAF, *M*, and *SD* of the Study 1 (Continued)

Factor / Item	Loading	*M*	*SD*
Conceived Imagination			
I often set the goal in accordance with my ability.	.324	4.24	0.820
I constantly revise my ideas to reach the perfect point.	.424	4.08	0.850
I often deliberately reason the contradictions of a problem.	.443	4.13	0.840
I can make a connection between irrelevant clues.	.348	4.00	0.914
I am ruminating on the project and put forward different ideas.	.330	3.94	0.921
Transformative Imagination			
I often express my feelings by using concrete ideas.	.790	4.18	0.949
I can express abstract ideas by using examples in daily life.	.913	4.25	0.992
I can illustrate the difficult ideas with some key concepts.	.875	4.10	1.007
I can explain unfamiliar concepts with examples common to the target audience.	.818	4.12	0.958
I can integrate different points of view to become my own thoughts.	.502	4.31	0.932
I often apply my experiences of daily life to class projects.	.663	4.18	0.930
I can flexibly reproduce my ideas to multiple fields of tasks.	.581	4.14	0.915
I can transfer similar ideas to various situations.	.608	4.24	0.884

results of *M*, *SD* and PAF of the study 1 refer to Table 3.

The study 2 conducted a confirmatory factor analysis to confirm the established structure in a sample of 612 college students (serving the validation sample). With respect to imaginative capability, the three-factor solution yielded acceptable fit for this study (X^2 = 1,867.17; df = 374; $p < .005$; RMSEA = .078; SRMR = .068; CFI = .96; NFI = .95; TLI = .96).

According to our data, the composite reliability (CR) of Factor 1 (initiative imagination) was 0.90; the CR of Factor 2 (conceived imagination) was 0.92, and the CR of Factor 3 (transformative imagination) was 0.89. The analysis of the composite reliability estimates demonstrated that the ICS has strong internal consistency (Fornell & Larcker, 1981).

Construct validity is examined in terms of convergent validity and discriminant validity. Convergent validity of each factor was tested by examining the standardized factor loadings. Accordingly, factor loadings should be .50 or higher, then the convergent validity is achieved (Hair, Black, Babin, Anderson, & Tatham, 2006). Loadings for the ICS ranged from .52 to .80 (initiative imagination .63 ~ .80, conceived imagination .52 ~ .73, and transformative imagination .72 ~ .78), suggesting good convergent validity.

Discriminant validity in this study was tested using Chi-squared differences. Based on Bagozzi and Phillips (1982), we compared the restrictive model with less restrictive models by examining the difference in X^2 and the difference in the degrees of freedom. If the difference is statistically significant, it provides evidence of discriminant validity. Our results showed that the X^2-difference between the restrictive and less restrictive models was 429.98, and the difference in the degrees of freedom was 3. Both differences reached a significant level ($p < .01$).

According to our results, *Initiative Imagination* can be defined as the capability to explore the unknown and productively originate novel ideas. *Conceived Imagination* can be defined as the capability to mentally grasp the core with personal intuition and sensibility, and to formalize effective ideas about the goal through concentration and logical dialectics. *Transformative Imagination* can be defined as the capability to crystallize the abstract ideas and reproduce what have known across different domains and various situations. Our findings implied that *Initiative Imagination* is the core of creative imagination, and *Transformative Imagination* is the substance of reproductive imagination. *Conceived Imagination* serves as an engine to form and shape the mental images generated from both *Initiative Imagination* and *Transformative Imagination*.

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