HOW LEARNING ENVIRONMENTS CAN STIMULATE STUDENT IMAGINATION

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ABSTRACT
The purpose of this study was to investigate an array of environmental factors that can stimulate imagination and explore how these factors manifest in different design phases. The participants of this study were students in the field of educational technology from four universities across Taiwan. The instructional design process was divided into three major phases: analysis, design/development, and implementation/evaluation. Influences in the learning environment were deconstructed into four factors: physical component, organizational measure, social climate, and human aggregate. The results of this study indicated that environmental factors have varying effects during the three phases of instructional design. The social climate was claimed to have the greatest effect on stimulating imagination, followed by organizational measure, human aggregate factor, and lastly physical component. These effects were seen in the development process, especially in phase two and with a lesser effect in phase three.
Keywords: educational technologist, imagination stimulation, instructional designer, learning environment

INTRODUCTION

Given the recent infusion of technology in almost every aspect of human lives, educational technologists are struggling with integrating technology into a variety of educational settings. Furthermore, highly advanced ICT infrastructure and the government's implementation of e-learning policies have accelerated the nationwide development of e-learning and forced educators to face a large number of tasks and related problems. One major problem that has emerged is the fast growth of technological applications without the necessary transformation of conventional pedagogical practices, or the assistance to learners in gaining the skills, knowledge, and attitudes for having a better quality of life.

AECT (2004) defined the field of educational technology as "the study and ethical practice of facilitating learning and improving performance by creating, using, and managing appropriate technological processes and resources." The definition suggests that educators should take technological resources and learning activities into account to extend the curriculum for students. Students thus could use technology as a system to make content more engaging and meaningful. However, design is iterative and involves ill-structured rather than well-formed problems (Ertmer et al., 2008; Jonassen, 2008). Therefore, Roschelle & Jackiw (2000) contended that designing educational experiences is an imaginative art.

Instructional designers construct activities and anticipate conversations and actions that will bring learners' inquiry to fulfillment, enabling their growth toward desirable skills and understandings. Fabricating such meaningful experiences not only requires a significant amount of expertise, but also creativity and imagination. It involves imagining how learners learn; how they respond to a task; where, with whom, and how they work; using which resources under which circumstances; and over what timescale (Goodyear & Retalis, 2010). Moreover, designers need to have imagination to forecast emerging technologies and their potential applications. However, until now, few studies have clearly discussed imagination in the field of educational technology, let alone developed an evaluation tool for assessing imagination stimulation.

Educational technologists are always interested in how the digital world changes the educational landscape. They need to care more about how learners use these technologies to gain knowledge and skills, and how physical component and social environments where the technologies are used would influence their learning. With these concerns in mind, this study aims at exploring what environmental factors influence imagination of students majoring in educational technology, how these factors influence students in different design phases, and how demographic backgrounds manifest themselves in these influences. 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. Such images are usually developed from the individual's image memory and shaped into something new.

IMAGINATION STUDIES

Imagination enables people to go beyond actual experience and construct alternative possibilities in which a fragmented situation becomes a meaningful whole (Passmore, 1985). Individuals have the potential to make creative discoveries through their imagery. Therefore, imagination can be perceived as the basis for cultivating creative thinking, and thus is the driving force of innovation (Finke, 1996). In addition to fantasy, imagination has several noticeable characteristics, some of which are related to psychology aspects, such as: exploration, intuition, sensibility, and crystallization; while some are more practice-oriented, such as: effectiveness, novelty, transformation, elaboration, and productivity (Liang, Chang, Chang, & Lin, 2012).

Valett (1983) indicated that children *explore* the world through playing, and Thomas (1999) followed that the process of controlled perceptual exploration takes individuals from a vague appreciation to a detailed understanding of reality. Colello (2007) also asserted that imagination allows one to explore, dare, challenge institutional order, and thus overcome limits. *Intuition* also has a place in human imagination. Intuition makes imagination concrete as a judgment and equivalent to a conclusion, which leads to a foresight of the future (Ribot, 1906). Townsend (2003) believed that if people utilize more intuitive representations, then their imagination would last longer. Reichling (1990) contended that knowledge is gained directly as an insight, or a grasp of the whole through intuition. She further claimed that most of imagination is emotive content, with an intuitively *sensible* meaning. Vygotsky (2004) supported that the ability to control imagination comes with the maturation of emotion. Another psychology-related characteristic of imagination is *crystallization*. DeVries (1988) illuminated Hegel's theory of mental activity and added that imagination connects "abstract properties" and "concrete universals" by law of association. Vygotsky (2004) concluded that all objects of common life appear as crystallization of the imagination.

Accordingly, *effectiveness* is one of the practice-oriented characteristics of imagination. It can be said that every invention has resulted from a particular human need and has its own special purpose (Ribot, 1906). Betts (1916) added that people are in danger of drifting into daydreams, unless their imagination is guided by some purpose. Reiner and Gilbert (2000) further confirmed that imagination is goal-oriented, based on prior experiential imagery and internal coherence. The imaginative effectiveness has its link to *novelty*. Betts (1916) held that imagination is an inventive power which allows the ability to see the old in new relations, and thus build new constructions out of old materials. Beaney (2005) indicated that someone who is imaginative is good at creating new possibilities, and can offer fresh perspectives on what is familiar. *Transformation* thinking will also bring useful outcomes to novel combinations (Lombardo, 2010). Imagination assists people in transferring a function from one object to another that did not previously have such a function (Vygotsky, 1978). This ability helps people in dealing with unpredictable problems by using existing experiences.

Besides providing intuitive insight, an individual's imagination can also take time. When people *elaborate* ideas, imagination becomes a long, laborious, and painful personal moment (Ribot, 1906). Through acts of dissociation and association, an inventor's imaginative constructs are challenged, corrected, and united, until they are adapted to a social consciousness. The process of elaboration is similar to the ideas of 'zooming in and out' described by Reiner et al. (2000), and the focusing-defocusing structure proposed by Folkmann (2010). *Productivity* is another characteristic of imagination, especially in terms of quantity, intensity, and duration of mental images (Ribot, 1906). Concerning the design process, Folkmann (2010) claimed that imagination starts as either an overall conception of the design as a whole, or a more experimental exploration for details. Both positions clearly state the success criteria for the design task in terms of imagination productivity, continuity, and fluency. In the current study, "imagination" refers specifically to the process of transforming the inner imagery of educational technology students when they face an instructional design task. Such transformation is assessed in terms of the characteristics identified above.

LEARNING ENVIRONMENT

Huebner (1989) indicated that "behavior is best understood and predicted through the transactions of individuals and their environment (p. 165)." Through the works of behavioral scientists, psychologists, and sociologists, research has shown that the environment can facilitate, modify, and hinder certain human behaviors and emotions (Speller, 2006). Thus, it could be viewed that student behavior is shaped and influenced by the multi-dimensional campus environment and vice-versa (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). There are a myriad of variables related to each of these dimensions, which accounts for the complexity of the campus environment.

The *physical component* dimension of a campus consists of its natural environment (location, weather, temperature, etc.) and its man-made environment (architecture, sound, facilities, messages, etc.). Both components shape attitudes toward the campus and influence its inhabitants' experiences in powerful ways. They also define space for activities and events, thereby encouraging some phenomena while limiting others, thus influencing students' preferences and behaviors (Strange, 2003). The major components of a physical environment include: (1) ambient environment, (2) environmental load, (3) personal space, (4) territories, and (5) crowding (Gifford, 2007; McAndrew, 1993). 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 of 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? The complex nature of universities results in the need to maintain a sense of order and generate various arrangements that define the organizational characteristics of an environment. As a result of this need, rules and regulations are formed, rewards systems are developed, and reports become necessary for resource allocation (Strange, 2003). 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 to the influence of organizational measures on students' creativity and imagination development.

The *social climate* dimension focuses on the "subjective views and experiences of participant observers, assuming that environments are understood best through the collective perceptions of the individuals within them" (Strange et al., 2001, p. 86). Environments can also be described in terms of organizational climates, which are composed of relationships, personal growth, and system maintenance (Moos, 1979). The social climate usually has intrinsic influence (such as members' motivations) as well as external impact on the environment (such as control over the members) (Peterson & Spencer, 1990). McMillan (1995) held that the emotional factor is the key to cultivate student imagination, such that all schools should create an educational climate that is full of encouragement and support.

The *human aggregate* dimension is 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; Strange et al., 2001). These features stress the uniqueness of the organization and provide a sense of belonging for its members. This dimension affects the students' performance, restricts their behaviors, creates campus culture, and produces a stable impression of the school (Peterson, & Spencer, 1990). Modern research (e.g., Claxton et al., 2006; Treadaway, 2009; Trotman, 2006) also echoes the impact of human aggregate on an individual's imagination. For the purposes of the current study, the learning environment is categorized into the four dimensions reviewed in this section.

METHOD

The current study adapted the ADDIE model and divided the instructional design process into three phases: Analysis, Design/Development, and Implementation/Evaluation. Since measures of the influence that environmental factors had on stimulating imagination in different design phases were unavailable, new scales needed to be developed. Based upon the literature reviewed previously, nine items were created to represent imagination characteristics, and 21 items were created to represent various environmental influences. The environmental items were grouped into four dimensions: physical component, organizational measure, social climate, and human aggregate. The items were scored on a five-point Likert scale ranging from 1= *strongly disagree* to 5= *strongly agree*. Face validity of these items were examined by five research associates and a small group of graduate students to clarify its comprehensiveness and meanings. A pilot study was also conducted consisting of 60 students in the educational technology field to examine the constructed scale. Based on the satisfactory analytical results, the formal questionnaire was confirmed.

Participants involved in this study were students from four universities across Taiwan. Students had to satisfy two requirements in order to participate for this study. They had to be currently majoring in educational technology field, and have similar assignments in instructional design based on the agreement between the instructors and this research team. In order to ensure the quality of this study, the research team communicated the survey with instructors in the target universities first, and then arranged similar schedules and assignments. In other words, this study could be implemented across multiple campuses under comparable timetables and similar design tasks.

The investigation process delivered in each university followed the same procedure. Each participant received a cover page and a questionnaire in a package. On the cover page, all participants were informed that their involvement was voluntary and they were guaranteed anonymity. In the questionnaire, students were asked to determine the level of agreement with each imagination characteristic, and the strength of influence that each environmental item had on their imagination in the current design phases. Although the design process is iterative, a systematic approach of instructional activities that allow students to gradually grasp complicated concepts is often times needed. The questionnaire was thus distributed in three different periods which represented the three instructional design phases of analysis, design/development, and implementation/evaluation during the fall semester of 2011. Data collection of each survey was conducted by well-trained graduate assistants who were accompanied by the class instructor.

Due to prior communication between the instructors and the research team, the valid samples collected in three different phases were well-controlled to be the same. Within these 402 subjects, 61 were freshmen, 116 were sophomores, 89 were juniors, 19 were seniors, and 117 were in their master programs. There were 152 men and 250 women. Data was analyzed using SPSS version 17.0 software. The measured items were organized by item analysis on the mean of imagination (3.21-3.92), the mean of learning environment (3.55-4.23), standard deviation (> .75), skewness (< ±1), extreme value test results ($p < .05$, $t > \pm 1.96$), correlation coefficients (> .3), and factor loading values (> .3) of the data acquired during the formal survey. The reliability test of the scale was conducted and found to be satisfactory to warrant confidence in internal consistency reliability (refer to Table 1).

Table 1: Demographical information of the sample

Demographical information		Phase 1 to Phase 3	
		Frequencies	Percentage
N		402	
Gender	Male	152	37.8%
	Female	250	62.2%
Academic standing	Freshmen	61	15.2%
	Sophomores	116	28.9%
	Juniors	89	22.1%
	Seniors	19	4.7%
	Master Program	117	29.1%

RESULTS AND DISCUSSIONS

Due to the novelty of this research topic, a Principal Component Analysis (PCA) with promax rotation was conducted to determine the most appropriate structure of the developed scales. The number of factors to be extracted for this analysis was determined using a number of criteria: 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. The Kaiser-Meyer-Olkin measure of sampling adequacy was .84, indicating that the sample had a sufficient level of factorability. Based on these criteria, the integrative single-factor solution (explained variables of 33.27%) with an oblique rotation provided the better factor structure both conceptually and statistically. The concept of imagination included items related to productivity, transformation, sensibility, intuition, novelty, exploration, effectiveness, crystallization, and elaboration. The results also showed that the internal consistency of imagination (.81) was considered stable (refer to Table 2).

Table 2: Factor loading and descriptive statistics of the imagination characteristics

Characteristic (Item)	Factor	*M*	*SD*
Productivity (I constantly have ideas toward my designs)	.73	3.27	.80
Transformation (I am flexible in my thinking and can transfer ideas to multiple fields of tasks)	.67	3.55	.76
Sensibility (I often help myself imagine by arousing personal feelings)	.63	3.70	.73
Intuition (I often come up with new ideas leading by my intuition)	.60	3.78	.76

Novelty (I often have uncommon ideas compared to others)	.57	3.21	.78
Exploration (I like to explore unknown areas of knowledge and experience)	.57	3.92	.69
Effectiveness (I often complete my tasks by focusing on effective ideas)	.52	3.57	.71
Crystallization (I am good at expressing abstract ideas by using concrete examples)	.46	3.50	.81
Elaboration (I improve my thoughts by focusing on formalizing ideas)	.37	3.44	.82

In reality, design activities are compound processes that often include iterations or re-definitions of the problem. In order to gain a holistic view of factor structure, the research team combined all the data regarding environmental influence of the three phases and made an integrative factor analysis. The results indicated that the 21 items could be organized into four learning environment factors. The first factor, *social climate*, a seven-item scale (M = 4.04, SD = .54), measured the extent of which participants reported being influenced by the climate of the class. The second factor, *physical component*, a five-item scale (M = 3.55, SD = .48), measured the degree to which participants considered the facilities and messages in an environment would stimulate imagination. The third factor, *organizational measure*, a six-item scale (M = 3.99, SD = .51), assessed participants' perceptions of the influence from the institutional structure and organizational measures. The fourth factor, *human aggregate*, a three-item scale (M = 3.91, SD = .67), indicated the degree to which participants felt that their imagination was influenced by the environment's organizational culture, tradition, or style. This four-factor solution accounted for 50.05% of the variance. Table 3 reports eigenvalues, factor explained variance, cumulative accounted variance and Cronbach's α. Table 4 presents factor loading values of the integrative factor analysis.

Table 3: Eigenvalues, cumulative accounted variance, and Cronbach's α of the four factors

Factors	Eigenvalues	Cumulative variance	Cronbach's α
1: Social climate	8.646	38.86	.87
2: Physical component	1.645	44.31	.79
3: Organizational measure	1.157	47.76	.82
4: Human aggregate	1.009	50.05	.89

Table 4: Factor analysis of the 21 items in learning environment

Factor / Item	Phase 1 to Phase 3			
	F1	F 2	F 3	F 4
Factor 1: Social climate				
Mutual support between teachers and classmates	.85			
Teacher's attention over the design process	.80			
Communication and discussion with classmates	.48			
The willingness to accept challenges in class	.46			
Competitive learning climate	.44			
Climate of respecting diversity and free expression in class	.39			
Pleasant learning climate	.38			
Factor 2: Physical component				
Environmental factors such as materials, furnishings, and other interior design		.81		
Dynamic audiovisual stimuli such as rhythm, sound, and movies		.76		
Static visual stimuli such as content, composition, and proportion of images		.70		
Environmental factors such as lighting, sound, and other infrastructure design		.62		
Public spaces for exhibitions and discussion		.43		
Factor 3: Organizational measure				
Teacher's tolerance for error			.66	
Rich learning resources provided by the department			.58	
Teacher's encouragement and praise for taking risk			.57	
A personal space for creation provided by the department			.52	
Explanation and guidance offered by teachers during the design process			.47	
Opportunities provided by teachers for concentration and solitary thinking			.39	
Factor 4: Human aggregate				
There is a culture on campus of putting imagination into practice				.84
There is a tradition of encouraging imagination in the department				.80
Teacher's respect for individual differences				.33

Overall, the *social climate* was claimed to have the greatest effect on stimulating the student's imagination, followed by *organizational measure* and *human aggregate*. Although the *physical component* had the smallest effect, its mean (3.78) was high enough to be considered influential. This result suggests that a soft mechanism like a welcoming climate is the most powerful stimulus to facilitate imagination. Harder factors like institutional measures, intangible factors such as tradition or culture, and physical environment like space and its facilities, are also effective stimuli.

Furthermore, a regression analysis was conducted to analyze whether or not gender and academic standing would result in differences on imagination stimulation. There were no significant differences between genders but there were differences depending on academic standing. The graduate participants claimed that their imagination was greater than the undergraduate subjects. This result may be partially because graduate students are more mature in both personality and expertise, and tend to be more independent, more disciplined and show more initiative. Their life and professional experiences are also richer than undergraduates. All of these qualities allow them to be more confident on this survey.

In the aspect of environmental influence, statistics showed that there was a significant effect which *physical component* had on different genders at the $p < .05$ level. The mean of female participants was significantly greater than that of the male. There was not enough evidence to conclude that the imagination of female students was more easily influenced by surrounding environment, but this study opens up a valuable issue to be inquired in the future. In addition, the means of graduate participants were significantly greater than those of the undergraduate subjects in both factors of *social climate* and *organizational measure*. Taken together, the results suggest that special attention should be paid to the physical environment for the female students, and the organizational measure and social climate to the graduates (refer to Table 5).

Table 5: Regression analysis on gender and academic standing differences

Variance	Gender	Academic standing
Imagination		0.13*
Learning environment		
Social climate		0.17*
Physical component	-0.11*	
Organizational measure		0.17*
Human aggregate		

Note: A paired-comparison technique was employed to observe differences among academic standings.
*$p < .05$.

Moreover, the results of the F test and paired comparison technique indicated that means of both phase 1 (analysis) and phase 2 (design/development) were greater than those of phase 3 (implementation/evaluation) in the *social climate* and *human aggregate* factors. The results of *organizational measure* were similar, but mean of phase 2 here was significantly greater than that of phase 1. In addition, the mean of phase 2 was significantly greater than those of both phases 1 and 3 in the *physical component* (refer to Table 6). The results suggest that environmental variables have significant effects on imagination stimulation, especially in the first two phases. Specially, the effect of the *organizational measure* in the second phase was significantly greater than in the other phases.

According to personal experiences, the results of this study are compatible with the reality of the educational technology system. For example, both discussion with classmates and free expression in class are important for stimulating imagination in the phase one in order to clarify the design task and initiate action. Having a pleasant learning climate and rich learning resources are critical for concept development in phase two. Mutual support between teachers and classmates and teacher's tolerance for error are crucial for the third phase. The results also imply that a set of unique instructional strategies applied during both phases one and two could be particularly beneficial to students. These results also echo the study done by Büscher et al. (2004) in which the work environment, the tools to be used, and the nature of the task were sought out to form the best combinations for designers to utilize their imagination.

Table 6: F test and paired comparison for environmental influences on the three different phases

Factors	Mean			F	Paired comparison
	Phase 1	Phase 2	Phase 3		
Social climate	4.06	4.08	4.00	12.56*	1 > 3; 2 > 3
Physical component	3.74	3.90	3.70	24.41*	2 > 1; 2 > 3

Organizational measure	4.01	4.06	3.89	26.93*	2 > 1 > 3
Human aggregate	3.93	3.96	3.85	11.28*	1 > 3; 2 > 3

*$p < .05$.

The research team examined the relationship between the imagination and environmental factors, and found it reached a significance level, $p < 0.05$. In the integrative analysis of the different design phases, the averaged correlation coefficient is .3, and the individual coefficients are between .23 and .35 (refer to Table 7). The averaged correlation of the first phase is .25, .28 for phase two, and .27 for phase three. The results also showed that the four environmental factors were significantly correlated, $p < 0.05$. The averaged correlation coefficient of the integrative process is .62, and the individual coefficients are between .45 and .74 (also see Table 7). The averaged correlation of the first phase is .55, .59 for phase two, and .58 for phase three. Specifically, the correlation of *social climate* and *organizational measure* was noticeably high. This result may imply the interrelationship between these two factors. It also implies that the items of these two factors may be overlapped and thus may need to be modified further.

Table 7: The correlation analysis of the imagination and environmental factors

	1.	2.	3.	4.	5.
1. Imagination	--				
2. Social climate	.35*	--			
3. Physical component	.30*	.57*	--		
4. Organizational measure	.34*	.74*	.53*	--	
5. Human aggregate	.23*	.66*	.45*	.62*	--

*$p < .05$.

The research team further utilized the maximum likelihood estimator of structural equation modeling method with LISREL 8.80 to examine the relationship between environmental factors and imagination. The following indicators recommended by Hu and Bentler (1999), Jöreskog and Sörbom (1996), and Tabachnick and Fidell (2001) was used 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).

The results showed a good fit to match the hypothesis that four environmental factors influence imagination, with $X^2(395)= 1104.13$; CFI = .96, RMSEA = .07, SRMR = .06, TLI = .95. The squared standardized path coefficient of the *social climate* is .0441, the *physical component* is .0144, the *organizational measure* is .0625, and the *human aggregate* is .0225. The residual of this analysis is .81 which makes the total explained variables 19%. This result is possibly because of the high correlations among environmental factors. The high multicollinearity caused an unstable parameter estimation which, in turn, may result in the insignificant prediction result. The other inference by the research team is that, similar to multiple influential factors on human creativity (Shalley, Zhou, & Oldham, 2004), the learning environment is only but one factor stimulating a learner's imagination. Additional factors such as psychology and personality should be added for further inquiries.

CONCLUSIONS

The increasing rate of change in human society and the escalating penetration of advanced technology require us to learn more to cope. As Marshall (2001) claimed, the more quickly things change, the more imaginative we have to be to keep up. Educational technologists need a more radical and holistic imagination to distinguish between enduring fundamentals of learning and teaching, and the transient froth splashed up by new waves of innovation (Goodyear et al., 2010). In other words, educational technologists not only need technological imagination to make predictions about the future, but also need to engage with the practical problems of educational reform in a rapidly changing society. Even more, educational technologists today need to foster a hybrid imagination, mixing scientific and technical skills with a sense of social responsibility (Jamison & Mejlgaard, 2010). Bearing these expectations in mind, this study inquired imagination under a certain societal environment, and tried to learn how this environment influences the inhabitants' imagination. This particular environment is the higher education system.

Imagination in this study is defined as the process of transforming an instructional design student's inner images. The results of this study indicated that imagination is consisted of several characteristics: productivity, transformation, sensibility, intuition, novelty, exploration, effectiveness, crystallization, and elaboration.

However, we ask ourselves, can these nine characteristics represent imagination in full? In other words, are there any other characteristics together with the present ones which can signify imagination thoroughly? According to the recent studies, the research team proposed that the indicator of elaboration could be divided into two independent items for further study namely, dialectics and focusing (e.g., Cartwright & Noone, 2006; Folkmann, 2010).

On the other hand, the learning environment is composed of four factors: social climate, physical component, organizational measure, and human aggregate. The *social climate* was claimed to have the greatest effect on stimulating the student's imagination, followed by the *organizational measure*, *human aggregate* and *physical component*. This study also found that there was a significant relationship between imagination and environmental factors, thought the correlation coefficients were not considered high. In addition, 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.

The graduate participants declared to have a higher imagination than the undergraduates. The female participants weighted the influence of *physical component* on imagination stimulation to be greater than the male; and graduates weighted the influences of both *social climate* and *organizational measure* to be greater than the undergraduates. The possible explanations and suggestions are presented in the previous section. The environmental influences of the first two phases (analysis and design/development) are greater than those in the final phase (implementation/evaluation). Specifically, the physical and organizational influences of phase 2 were significantly greater than those in phase 1. All of these findings have implications for instructional strategies of imaginative education in the educational technology field.

It is the authors' belief that an excellent designer who is capable of simulating invisible possibilities is only able to because he or she has an exceptional imagination. Compared to concepts such as personal characteristics and inner psychology, external environments are factors which are easier to grasp and shape. It is also easier to adjust the learning environment with different instructional strategies than to change an individual's characteristics or psychology. The learning environment and curriculum must inspire students' passion for excellence, nurture their curiosity, develop their imagination, empower their professional life, and awaken their spirit for an unknown future.

ACKNOWLEDGEMENTS

The current study is part of the research projects (NSC98-2511-S-155-005-MY2) supported by Taiwan's National Science Council. The authors would like to extend their gratitude to Li-Jhong Lin in National Taiwan University for his valuable contributions in statistical analysis. Furthermore, the authors also would like to acknowledge the insightful suggestions of anonymous TOJET reviewers and the Editor in Chief Prof. Dr. Aytekin İŞMAN.

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