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The Perceived Influence of Learning Environment on Design Student Imagination

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Abstract. This study was aimed to analyze the perceived influence of learning environment on design student imagination in different design phases. Participants (n = 1,004) involved in this study were design school students from ten universities across Taiwan. Influences in the learning environment were deconstructed into four factors: physical component, organizational measure, social climate, and human aggregate. Our results indicated that *social climate* was claimed to be the greatest influential factor, followed by *organizational measure*, *human aggregate*, and finally *physical component*. These various effects were seen in the design process, especially in the phase of problem definition and design analysis, and with a lesser effect in the phase of detailed design and communication.

Keywords: design education; design process; imagination stimulation;learning environment.

Introduction

The key to the success of the design lies in the capacity of creative thinking. Imagination is the basis for cultivating creative thinking, and thus the driving force of innovation (Finke, 1996). Creativity-related research has progressed for many years, but the understandings of imagination and the imagination process still remain unclear. So far, few studies have clearly discussed how imagination manifests itself, let alone developed an evaluation tool for assessing imagination stimulation in the design field (Liang, Chang, Chang, & Lin, 2012). In this study, "imagination" refers to the process of transforming the inner imagery of design school students when they face a design task. Such images are usually developed from the individual's image memory and shaped into something new.The purpose of this study is to analyze the perceived influence of learning environment on design student imagination in different design phases. Generally speaking, the design process can be divided into three major phases: problem definition and design analysis, concept development and prototyping,

and detailed design and communication (Shneiderman, 2000; Peffers et al., 2006).

Learning environment

The college campus can be divided into four dimensions: its physical components and design, its dominant human characteristics, the organizational structures that serve its purposes, and the participants' constructions of its social climates (American College Personnel Association, 1994). The *physical component* of a campus consists of its natural environment (geographic location, weather, and temperature) and man-made environment (architecture, signs, sound, grassy spaces, learning facilities, and messages sent to its inhabitants). These two components define space for activities and events, thereby encouraging some phenomena while limiting others (Strange, 2003). *Social climate* 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& Banning, 2001, p. 86) This dimension usually has intrinsic influence (such as members' motivations) as well as external impact (such as control over the members) (Peterson & Spencer, 1990).

With respect to *organizational measure*, 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. *Human aggregate* is the collective characteristics of people who inhabit the environment. Whether demographic or psychosocial, this dimension creates features in an environment that reflect varying degrees of differentiation and consistency (Strange& Banning, 2001). The human aggregate dimension is reflected in organizational culture, tradition, or style (Huebner &Lawson, 1990). These features affect the students' performance, restrict their behaviors, and produces a stable impression of the school (Peterson & Spencer, 1990).

Imagination

Passmore (1985) held that imagination is the capacity to think up and think through alternatives. Imagination enables people to go beyond actual experience and construct alternative possibilities, in which the fragmented situation is a meaningful whole. Trotman (2006) indicated that imagination is an essential human capacity in various activities such as the pursuit of creativity and innovation, the symbolic expression of ideas, and critical thinking. In other words, imagination is the internal imagery of a creator whereas creativity and creations are the outward manifestation of imagination. Imagination can also be viewed as the process of transforming an existing memory into a new form.

Reichling (1990) indicated that imagination runs through three levels: fantasy or magical imagination, reproductive or literal imagination, and metaphorical and paradoxical imagination. At the level of fantasy or magical imagination, the initial stage of imaginative development, perception is dominant. The imagined

object may be "seen" or "touched" within the mind of an individual. At the level of reproductive or literal imagination, perception and reasoning are combined together, but intuition is largely absent. Objects at this level are imagined as they exist in concrete and observable forms. At the level of metaphorical and paradoxical imagination, the addition of intuition brings the last facet of imagination together with perception, thinking, and feeling. This combination yields the full development of imagination as a power of the whole human consciousness.

Trotman (2006) claimed that imagination engagement can be seen as situated practices. Trotman further proposed six situated practices: solitary imagination, contemplative imagination, imaginative correspondence, contributory imagination, imaginative dissonance, and reciprocal collective imagination. *Solitary imagination* is a necessary prerequisite of imaginative experience, and is identified as the critical agency for facilitating learning, thinking, and innovation. Contemplative imagination is a moment of conscious engagement in the deep subjective life world. In the situated practice of *imaginative correspondence*, imaginative experience enters the realm of an inter-subjective world in which the world is one that is shared and interpreted by others. In*contributory imagination*, individuals have opportunities to make their unique contributions to a shared project. An exchange in imaginative disagreement leads to the situated practice of *imaginative dissonance*. Imaginative dissonance is followed by the situated practice of *reciprocal collective imagination*, which Trotman indicates is characterized by community, unity, mutuality, reflexivity, and connectivity.

Passmore (1985) held that teachers should provide students with alternative thinking and diverse life experiences, thus stimulating imagination. Büscher, Eriksen, Kristensen, and Mogensen (2004) took concepts such as work environment, resources, and design tasks as variables and sought out the best combinations for designers to utilize their imagination and improve their cross-field capabilities. These studies demonstrated that imagination stimulation is closely related to the designer's work environment and the societal environment outside of the task.

Method

Since measures of the influence that environmental factors had on imagination stimulation in different design phases were unavailable, new scales needed to be developed for this study. Based upon the literature review, items were created to represent the issues identified. All these 27 preliminary items addressed various environmental influences and were grouped into four dimensions, namely physical component, social climate, organizational measure, and human aggregate.In order to make the standpoints of the surveyed clearer, the items were measured using 4-point Likert scales, ranging from 1 = strongly disagree to 4 = strongly agree. The scale was pre-tested by over 200 college students and then verified by preliminary validation analyses.

Participants involved in this study were students from ten universities across Taiwan. Students had to satisfy two requirements in order to participate for this study. First, students must have been a design major. Second, students must have had at least sophomore standing prior to the study. In the first phase, a total of 1,004 valid samples were collected, including 294 sophomores, 300 juniors, 277 seniors, and 133 in their master programs. There were 277 male and 727 female. The demographical data of the other two phases are presented in Table 1. Because the participants were not forced to contribute in all the three phases, the numbers of participants differed slightly between each phase.

The questionnaire asked participants to determine the strength of influence that each identified environmental factor had on their imagination in the current design phase. The questionnaire was distributed to the participants in three different periods. The first period, the phase of problem definition and design analysis, was during the first two weeks of October 2011. The second period, the phase of concept development and prototyping took place in the final two weeks of November 2011. The third and final period, the phase of detailed design and communication, was during the middle two weeks of January 2012. Each survey was conducted by trained graduate assistants who were accompanied by the course instructor.

Three items were dropped from the scale due to low factor loading (< .3): "the congestion of messages in the learning environment," "the route and pattern planning of the learning environment," and "the location of the learning environment on campus." Based on the satisfactorily analytical results, a total of 24 items were chosen to construct the formal questionnaire. The measured items were organized by item analysis on the mean (2.77-3.54), standard deviation (> .75), skewness (< ±1), extreme value test results (p < .05, t > ±1.96), correlation coefficients (> .3), and factor loading values (> .3) of the data acquired during the formal survey. The environmental influence scale was found to be reliable (refer to Table 1).

Table 1: Analysis of the demographical data and Cronbach's α

Demographical data & α	Phase 1 (n = 1,004)	Phase 2 (n = 974)	Phase 3 (n = 943)
Gender			
Male/ Female	277（27.6%）/ 727（72.4%）	293（30%）/ 681（70%）	266（28.2%）/ 677（71.8%）
Grade			
Sophomore/ junior	294（29.3%）/ 300（29.9%）	252（25.9%）/ 292（30%）	282（29.9%）/ 296（31.4%）
Senior/ master	277（27.6%）/ 133（13.2%）	300（30.8%）/ 130（13.3%）	252（26.7%）/ 113（12%）
Cronbach's α			
Whole/ item	.891/ .884-.891	.913/ .907-.912	.903/ .897-.910

Results

Factor analysis results indicated that the 24 items could be organized into four environmental factors. The first one, *physical component*, a six-item scale, measured the degree to which participants considered the facilities and messages in an environment would stimulate imagination. The second one,

organizational measure, a six-item scale, assessed participant perceptions of the influence from the institutional structure and organizational measures. The third one, *social climate*, a seven-item scale, measured the extent of which participants reported being influenced by the climate of the class. The fourth one, *human aggregate*, a five-item scale, indicated the degree to which participants felt that their imagination was influenced by the organizational culture, tradition, or style. Reliability estimates were satisfactory and are reported with factor loadings in Table 2. Four extracted factors explained a cumulative variance of 52.68%.

An independent samples t-test (95% CI) was conducted to compare gender differences. The statistics showed that there was no significant difference between genders in the three phases. However, the statistics also showed that the item "teacher's respect for individual differences" in the second phase achieved a significant level (p = .002 < .01). ANOVA was continually conducted to compare the effect of environmental factors on participant imagination stimulation between students of different grades. The study found that there was a significant effect of environment factors on imagination stimulation at the p< .05 level for the four conditions in all three phases.

In the first phase, the results of Scheffé test showed that the mean of sophomores (M = 3.18, SD = .44) was significantly greater than that of Master's students (M = 3.01, SD = .484) in *physical component*. The same was also true in *organizational measure* (M = 3.42, SD = .460 compared to M = 3.28, SD = .507). The mean of juniors (M = 3.45, SD = .430) was significantly greater than that of seniors (M = 3.32, SD = .471) and Master's students (M = 3.32, SD = .456) in *social climate*. Finally, the mean of sophomores (M = 3.45, SD = .439) was significantly greater than those of seniorsand Master's students in *social climate* as well. In the second phase, Scheffé post hoc comparison test showed significant differences between the means of juniors and those of seniors and Master's students in both *social climate* and *human aggregate*. In the third phase, the results showed significant differences between the mean of sophomoresand that of seniors in *social climate* (see Table 3).

Furthermore, the results of the Scheffé post hoc test indicated that means of both phase 1 (M = 3.112, SD = .460) and phase 2 (M = 3.108, SD = .498) were greater than that of phase 3 (M = 3.051, SD = .497) in *physical component*. In *organizational measure*, means of both phase 1 (M = 3.357, SD = .477) and phase 2 (M = 3.331, SD = .490) were also significantly greater than that of phase 3 (M = 3.239, SD = .527). In addition, the mean of phase 1 (M = 3.396, SD = .451) was significantly greater than that of phase 2 (M = 3.320, SD = .470), which itself was greater than the mean of phase 3 (M = 3.254, SD = .479) in *social climate*. The related results are reported in Table 4.

Table 2: Factor analysis of learning environment in the three design phases

Factor/Item		Phase 1					Phase 2					Phase 3				
		1	2	3	4	α	1	2	3	4	α	1	2	3	4	α
Factor 1: Physical component						**.686**					**.776**					**.780**
1.	Environmental factors such as: materials, colors, furnishings, and other interior design	.626				.627	.667				.732	.658				.740
2.	Environmental factors such as: lighting, sound, ventilation, and other infrastructure design	.569				.642	.657				.731	.601				.752
3.	Equipment, media, and tools provided by the department	.507				.625	.571				.732	.603				.733
4.	Public spaces for exhibitions and discussion	.465				.643	.526				.745	.557				□744
5.	Dynamic audiovisual stimuli (such as story, rhythm, sound, and movement of movies)	.372				.660	.494				.757	.477				.759
6.	Static visual stimuli (such as content, composition, line, color, and proportion of images)	.318				.673	.486				.756	.494				.753
Factor 2: Organizational measure						**.780**					**.806**					**.734**
7.	Teacher's encouragement and praise for taking risk		.702			.727		.706			.757		.779			.655
8.	Opportunities provided by teachers for concentration and solitary thinking		.639			.720		.653			.755		.659			.666
9.	Teacher's tolerance for error		.639			.746		.622			.770		.599			.681
10.	Explanation and guidance offered by teachers during the design process		.489			.758		.420			.794		.205			.797
11.	A personal space for creation provided by the department		.451			.749		.422			.775		.409			.686
12.	Rich learning resources provided by the department		.306			.778		.254			.799		.289			.702
Factor 3: Social climate						**.816**					**.828**					**.830**
13.	The willingness to accept challenges in class			.705		.784			.657		.801			.640		.801
14.	Competitive learning climate			.617		.803			.598		.820			.544		.821
15.	Teacher's attention over the design process			.507		.781			.502		.800			.569		.798
16.	Climate of respecting diversity and free expression in class			.475		.796			.484		.803			.491		.805
17.	Mutual support between teachers and classmates			.468		.780			.466		.800			.524		.801
18.	Communication and discussion with classmates			.457		.792			.559		.802			.555		.807
19.	Pleasant learning climate			.310		.806			.450		.811			.461		.813
Factor 4: Human aggregate						**.783**						**.811**				**.794**
20.	There is a tradition of encouraging imagination in the department				.700	.718				.766	.753				.674	.741
21.	There is a culture on campus of putting imagination into practice				.665	.741				.599	.783				.619	.765
22.	Teachers and classmates are willing to share and provide constructive feedback				.511	.750				.559	.769				.549	.751
23.	Teacher's respect for individual differences				.495	.741				.467	.776				.515	.755
24.	Teacher's demand on students taking initiative				.433	.760				.421	.790				.445	.765

Table 3:ANOVA and Scheffé tests of grade differences (environmental factors)

Factor	Phase 1			Phase 2			Phase 3		
	F	Sig.	Scheffé	F	Sig.	Scheffé	F	Sig.	Scheffé
Physical component	5.072	.002	2> 5						
Organizational measure	3.106	.026	2> 5				.937	.422	
Social climate	6.485	.000	2, 3> 4; 2, 3> 5	8.426	.000	3> 4; 3> 5	3.135	.025	2> 4
Human aggregate	.530	.662		7.024	.000	3> 4; 3> 5	1.225	.299	

*p< .05; 2 = sophomore, 3 = junior, 4 = senior, 5 = master.

Table 4:Scheffé tests of phase differences in the three design phases

Factor/Item	Phase 1		Phase 2		Phase 3		F	Sig.	Scheffé
	M	SD	M	SD	M	SD			
Physical component	3.112	.460	3.108	.498	3.051	.497	5.079	.006**	1 >3; 2 >3
1.	3.47	.768	3.38	.743	3.28	.736	20.252	.000***	1 >2; 1 >3; 2 >3
2.	3.37	.748	3.31	.726	3.20	.708	16.022	.000***	1 >3; 2 >3
3.	3.12	.647	3.18	.647	3.13	.692			
4.	3.01	.788	3.01	.775	2.96	.729	1.781	.169	
5.	2.95	.648	2.96	.656	2.96	.693	.297	.743	
6.	2.77	.808	2.81	.795	2.78	.763	.919	.399	
Organizational measure	3.357	.477	3.331	.490	3.239	.527	15.003	.000***	1 >3; 2 >3
7.	3.51	.704	3.43	.717	3.33	.713			
8.	3.45	.665	3.42	.638	3.32	1.173	12.048	.000***	1 >3; 2 >3
9.	3.39	.623	3.34	.662	3.27	.693	6.775	.001**	1 > 3
10.	3.37	.772	3.36	.741	3.20	.735	8.710	.000***	1 >3; 2 >3
11.	3.29	.626	3.30	.651	3.22	.673	2.468	.085	
12.	3.14	.717	3.13	.714	3.10	.712	.049	.952	
Social climate	3.396	.451	3.320	.470	3.254	.479	22.385	.000***	1 >3; 1 >2; 2 > 3
13.	3.54	.655	3.44	.681	3.39	.688	9.731	.000***	1 >2; 1 >3
14.	3.52	.719	3.45	714	3.36	.708	12.492	.000***	1 >3; 2 > 3
15.	3.52	.581	3.43	.621	3.32	.647	22.201	.000***	1 >2; 1 >3; 2 >3
16.	3.41	.658	3.32	.660	3.26	.696	12.344	.000***	1 >2; 1 > 3
17.	3.38	.595	3.34	.617	3.26	.638	8.578	.000***	1 >3; 2 >3
18.	3.20	.622	3.14	.657	3.10	.671	1.276	.279	
19.	3.20	.733	3.10	.729	3.08	.716	3.176	.042	
Human agregate	3.251	.520	3.221	.536	3.150	.520	9.358	.000***	1 >3; 2 >3
20.	3.45	.694	3.36	.701	3.26	.685	21.300	.000***	1 >2; 1 >3; 2 >3
21.	3.38	.662	3.34	.667	3.26	.691	8.195	.000***	1 >3; 2 >3
22.	3.24	.640	3.21	.663	3.13	.669	5.546	.004**	1 >3
23.	3.12	.709	3.13	.705	3.08	.716	1.198	.302	
24.	3.07	.831	3.06	.809	3.03	756			

*p< .05. **p< .01. ***p< .001; 1 = phase one, 2 = phase two, 3 = phase three

Discussion

Environmental factors of stimulating imagination

Overall, *social climate* was claimed to have the greatest effect on student imagination, followed by *organizational measure*, and *human aggregate*. Although *physical component* had the least effect, its mean (3.112) was high enough to be considered influential. This result suggested 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 factors like space and its facilities, are also proved themselves to be effective facilitators.

In the first phase of design process, our data showed that the top eight influential items on student imagination are "discussion with classmates," "pleasant learning climate," "climate of free expression," "encouragement for taking risk," "dynamic audiovisual stimuli," "opportunities for solitary thinking," "sharing constructive feedback," and "mutual support". This result is

consistent with both environment-related (e.g. encouraging climate, audiovisual stimuli) and imagination-related literatures (e.g. solitary vs. reciprocal collective, correspondence and contributory) reviewed earlier.

In the second phase, the most influential items include "pleasant learning climate," "discussion with classmates," "climate of free expression," "encouragement for taking risk," "opportunities for solitary thinking," "dynamic audiovisual stimuli," "rich learning resources," and "sharing constructive feedback". The item "mutual support" was dropped, partially due to the emphasis on the personal attribute of an individual imagination during this phase of design. The newly added item "rich learning resources" reflected the need of external stimuli (such as related cases, seniors' examples, competition messages) for the students in the design school.

According to the analysis, the seven most influential items in the third phase are "discussion with classmates," "pleasant learning climate," "encouragement for taking risk," "climate of free expression," "opportunities for solitary thinking," "dynamic audiovisual stimuli," and "a personal space for creation." The item "sharing constructive feedback" was dropped between phase two and phase three, possibly because the feedback might not be acknowledged within the busy schedule during the phase three. The addition of the item "a personal space" implied that the third phase is a time for detailed design. These results confirm the findings of the previous study (Liang, Hsu, & Chang, 2013; Liang, Hsu, Huang, & Chen, 2012), especially in the aspect of environmental factors.

The results indicated that there was no significant difference on the influence of environmental factors between male and female participants according to the t-test. However, environmental factors had greater influence on sophomores than on seniors and Master's students. This phenomenon was more evident in the first and third phases. The learning environment, especially *social climate* and *human aggregate*, had significant effects on the juniors in the second phase. Our results also suggested that special attention should be paid to *physical component* for sophomores in the first design phase, and *social climate* and *human aggregate* to juniors in the second phase.

Taken together, these results suggested that environmental factors have significant effects on imagination stimulation, especially in the first two phases. The factor of *social climate*and its items in the phase one is particularly influential. This implied that a set of unique instructional strategies applied during the phase one could be particularly beneficial to students. The results also echoed the study done by Büscher et al. (2004) in which work environment, tools to be used, and the nature of the task were sought out to form the best combinations for designers to utilize their imagination.

Imagination stimulation in the three phases

It should be restated that the first phase in the design process is the phase of problem definition and design analysis, the second phase is the phase of concept development and prototyping, and the third phase is the phase of detailed

design and communication. The results of this study are compatible with the nature and reality of design education. For example, discussion with classmates is important for stimulating imagination in the phase one in order to clarify the design task. Having a pleasant learning climate and rich learning resources are critical for concept development in the phase two. Opportunities for solitary thinking and a personal space for creation are crucial for detailed design in the third phase.

In order to clarify the design problem and assigned task, students in the first phase usually need to go back and forth between discussing with classmates and solitary thinking. Diverse audiovisual stimuli serve as vehicle for stimulating imagination, and a pleasant, encouraging and respecting climate facilitates this stimulation. Mutual support from both teachers and classmates, in the form of idea sharing or feedback, is always welcomed. According to our results, the scenario constructed above is especially crucial forsophomore students. Our data also showed that the physical environment is not the dominant factor in stimulating student imagination, but it should not become an excuse not to improve learning facilities and enhance learning resources.

The nature of the first phase involves both imagery and analysis. Proceeding from this paradoxical stage to the next one, the phase of concept development and prototyping, there was a trend of increasing importance on the items "opportunities for solitary thinking," and "rich learning resources." At the same time, the weights of "climate of free expression,""sharing constructive feedback," "mutual support between teachers and classmates" were slightly diminished. It might imply that students demand more referential material and time for scanning through ideas during this phase. The results revealed that constructive feedback along with a climate of respect and support are still needed to stimulate student imagination.

In the reality, the acts of concept development and prototyping dominate the second phase of the design process. According to the analysis of this study, special attention should be paid to junior students in the factors of *social climate* and *human aggregate* in this phase, especially through having a competitive and challenging climate and opportunities for discussion. The instructors, in this phase, should keep an open mind and take a more flexible standpoint in order to stimulate student imagination. In addition, sufficient referential resources and constructive feedback should be provided under a mutually respectful climate.

In the transition to the phase three, the importance of the items "opportunities for solitary thinking," "a personal space for creation," and "teacher's attention over the design process" was increased. These changes reflect a switch from prototyping to detailed design in a typical design process. Students may need more room for themselves during this period. However, it is ironic that student imagination could be enhanced if their instructors closely observe them through the process. In addition, the weights of "climate of free expression" and "sharing constructive feedback" were lessened. It implied that free expression and

constructive feedback might not be as important as in the previous phases due to time constraints.

The final phase is the time to examine the execution and completion of the design task. It is also a time to demonstrate a student's marketing ability. In order to facilitate imagination, our data showed that students in this phase continually discuss the task with classmates, and demand opportunities for solitary concentration and contemplation. A variety of audiovisual stimuli and personal space for creation is expected. A pleasant, encouraging, and respectful climate is still needed. As students devalued free expression and constructive feedback, it is interesting to learn that the need for mutual support between teachers and classmates grew.

Taken together, our results suggest that environmental factors not only have significant effects on imagination stimulation, but also have varying effects during the three phases of design process. Particularly, the effect of *social climate*, the most influential dimension, in the first phase was significantly greater than in the other phases. This phenomenon was also observed with the factors of *organizational measure*, *human aggregate*, and *physical component*. The only difference was that the effect of *human aggregate*in the phase two was significantly greater than in the phase three. This study concluded that environmental factors have significant effects on imagination stimulation for students in the design field, especially in the phase of problem definition and design analysis, and have significantly smaller effects on the phase of detailed design and communication.

This study also concluded that the student imagination in design field runs through the three imagination levels as described by Reichling (1990). These three levels were witnessed in each phase, sometimes intertwining without a particular sequence. In addition, the research team observed that students in the design field continually encountered the six situated practices claimed by Trotman (2006) throughout the design process. The situated practices are bounded by context and situation rather than design phase. As can be seen in Figure 1, a design process is composed of three phases. These designer-centered phases do not have strict boundaries. Each environmental factor has its unique influence in every design phase. In Figure 1, the size of each factor and its distance to the designer represent the respective influence that the factor holds. The designer in each phase travels back and forth on different imagination levels, and encounters all six situated practices. The imagination of a designer in the three design phases is continually creating and refining. The inventions and refinements in each phase in turn shape those in the next phase as presented in the following conceptual framework.

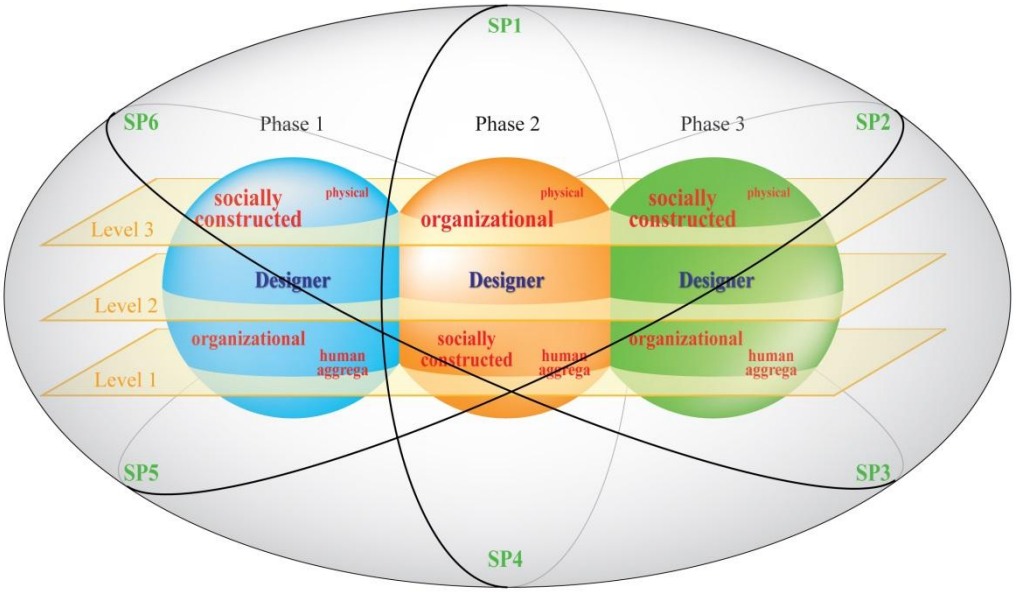

Figure 1: Conceptual framework of imagination stimulation by environments in the three phases

Notes:

1. Level 1: fantasy/magical; Level 2: reproductive/literal; Level 3: metaphorical/paradoxical (Reichling, 1990).
2. SP (Situated Practice) 1: solitary, SP 2: contemplative, SP 3: correspondent, SP 4: contributory, SP 5: dissonant, SP 6: reciprocal collective (as proposed by Trotman).

Closing Remarks

Compared to concepts such as personality traits and individual 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 traits or psychological states.

It should be noted that the research target of this study is students in the design field. It is expected that the reactions of this target population would differ from those of professional designers in the real world. This study, however, can serve as a stepping stone for inquiring into the imagination of professional designers. The study of the expected gap between naive designers and professional ones can lend insights for design educators to restructure or reinvent their curriculum and learning environments.

An excellent designer who is capable of simulating invisible possibilities is only able to because he or she has an exceptional imagination. How do we help our students construct imagery through the external learning environment? How do we help them facilitate the development of these memories? How do we help them translate their images into professional design capabilities? What instructional strategies can be adjusted and/or invented from this study? How can these strategies be implemented? All of these are crucial challenges for us, as educators in the design fields, to face.

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