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Analysis of Creativity and its Social Factors with Computer Science Engineering Students

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Abstract

In this work, we investigate the relationships among influence factors of learning environment on the creativity of students in the field of Computer Science and Information Engineering (CSIE). We first establish a hypothesis model of the environmental factors influencing creativity. Then, we investigate whether the environmental factors have a direct influence on the creativity of the CSIE students, or there exists any intermediate influences. In this work, an online questionnaire survey was conducted on CSIE students in National Chung Cheng University. A total of 161 valid samples were collected from February to April in 2017. The main influences in the learning environment were deconstructed into four factors: Human Aggregate, Organizational Measure, Social Climate, and Physical Component. The main result shows that Human Aggregate has a positive effect on Organizational Measure and Physical Component, and Human Aggregate also indirectly affects Organizational Measure through the Physical Component.

Keywords: Computer engineering, engineering education, creativity, learning environment

Introduction

Innovation and technology have gradually matured and as a result the lives of people have become relatively more convenient. Many companies have also incorporated creativity into their routine business strategies.

The creation of human culture and civilization grow with time, constant innovation, is dependent on the mental ability of human beings for the unknown possibilities, and this mental ability is “Imagination” (Wang & Huang, 2015). However, on the comparison of imagination and creativity, imagination is a complex concept, there is still no absolutely standard definition. It is also possible to say that imagination is basically a link to things that might not seem to be related at first (Liu & Noppe, 2009). On the other side, creativity rather emphasizes on originality, challenges old ideas, and give new points of view.

Objectives

The atmosphere of a team also affects the development of imagination. Recent study (Dirkx, 2001) have shown that through imagination, emotions can help our inner thoughts to connect with the outside world. Some students describe their classroom experiences as boring or stressful while others characterize them as fun and exciting. Some graduate students look to their classroom experiences as something that connects them more deeply with other learners and the campus. These observations suggest that emotions and feelings play a critical role in our sense of self and in processes of learning. Through learning and acculturation, we can investigate the relationships between the emotion attribute and the learning environment.

This study aims to find out the relationship among the influence factors, namely human aggregate, organizational measure, social climate, and physical component in environment, investigating whether CSE students are inspired by creativity during teamwork, by suggestions provided by teachers, and by new ideas from past views and learning environment.

Research Questions

The major problem is that the conventional pedagogical practices has been unable to keep up with the rapid development of science and technology. Lots of educational policy are struggling with integrating technology into a variety of educational settings. Furthermore, many scholars have also suggested in a scientific discovery and invention that a competent engineer also needs strong imagination to seek innovation to achieve effective work efficiency (Coeckelbergh & Wackers, 2007). Therefore, the lack of imagination is a matter of concern, which is also the main motivation of this study.

In order to achieve the creativity, the first influence factor is the environment (Release your creative, 2013), it is the outermost challenge, and is also the main idea of this study. When we look at some of the recognized and creative companies, the first impression is from their office environment. For example, Google, Facebook, 3M's office is what people think of the creative company's appearance. They transform their company's infrastructure and the way of leading, so that the office environment is lively and pressureless, to provide opportunities for employees to demonstrate creative performance. However, basic hardware infrastructure change is easy to change as the first step, but the related software infrastructure and the provisions of culture may be more complex to change.

Methodology

Measurements

The research process is divided into two parts: the theoretical framework and the case study. In the theoretical framework, we use literature discussion to collect articles related to creative thinking and environmental factors and then we set up the subject of research and motives. We use the collected articles to sort out the results of the comprehensive literature and summarize the appropriate hypothesis model, as shown in Figure 1.

H1a: Human aggregate has an influence on organizational measure.

H1b: Human aggregate has an influence on physical component.

H2a: Physical component can influence the social climate.

H2b: Physical component can influence the organizational measures.

H3: Social climate can influence the organizational measures.

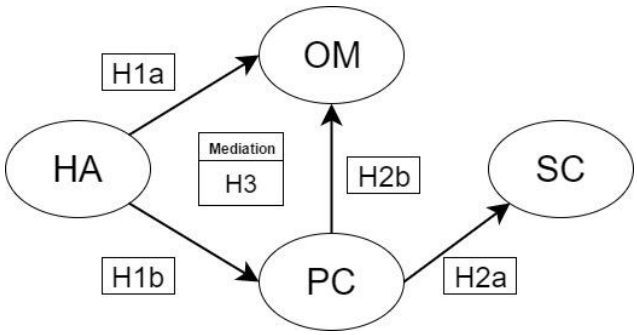

Figure 1. Hypothesis model of environment factors

In the case study, the questionnaire design and improvement were carried out on the basis of the above hypothesis model, and then the questionnaires were issued to the students

for investigation. Finally, the hypothesis model proposed in this study is discussed and analyzed.

In this study, SPSS 18.0 statistical software was used as data analysis tool, and AMOS 18.0 statistical software was used to verify the fit of the model proposed in this study. The constructs in Statics of this study are based on the creation of environmental factors proposed by the American College Personnel Association (Calhoun, 1994, & Kember, 2010). The questions in each construct are in the form of Likert's five-point scale, ranging from 1= strongly disagree to 5= strongly agree. There are 26 items created to represent various environmental influences based on the environmental influence scale in the related literature (Liang, 2012). The environmental items were devided into four factors: human aggregate, organizational measure, social climate, and physical component. Students had to satisfy a requirement in order to ensure the quality and purpose of this study. Each student must have a graduate project or thesis writing experience.

Participants and Procedures

The three proposed hypotheses were tested by using data obtained from students of Computer Sciences in National Chung Cheng University Data were collected from February to April in 2017. A total of 161 samples are consisted of 119 men and 42 women. Of the sample, 69.8% were undergraduate students, 30.2% were graduate students.

In this study, non-random purposive sampling was used as the sampling method. The questionnaires were collected by anonymously. The investigation questionnaire constructed by Google forms and the questionnaire URLs were forwarded through social networking sites and social software groups. In the questionnaire, students were asked to determine the degree of the strength of influence that each environmental item had on their imagination.

Literature Review

Learning Environment

When asking questions pertaining to creativity and collaboration within the learning environment, it is important to understand that the creative environment encompasses many aspects. Learning environment refers to the diverse physical locations, contexts, and cultures in which students learn (The glossary, 2014). Since students may learn in a wide variety of settings, such as outdoor or living environments. The learning environment also encompasses the culture of a school its presiding ethos and characteristics, including how individuals interact with and treat one another, as well as, the ways in which teachers may organize an educational setting to facilitate learning.

Since the qualities and characteristics of a learning environment are determined by a wide variety of factors, school policies, and other features may also be considered the elements of a "learning environment." Huebner indicated that behavior is the best understood and predicted through the transactions of individuals and their environment (Huebner, 1989), such as curiosity, creativity, collaboration, persistence, flexibility, revision, and even the classic habits of mind are all great places to start a good transaction. Many researches have shown that the environment can modify and hinder certain human behaviors and emotions (Speller, 2006). The majority of existing research touches upon factors on a broader level within the campus environment, such as school hierarchy, meeting place politics, and other managerial styles. In Amabile's creativity theory, he proposed that peoples' creativity depends not only on their personal characteristics, but also on their work environment (Amabile, 1996, Woodman, 1993).

Construct of the Learning Environments

According to the American College Personnel Association (Calhoun, 1994, & Kember, 2010), the learning environment in campus can be divided into four factors: human aggregate, organizational measure, social climate, and physical component.

The "human aggregate" factor emphases on the students' personality level of the campus environment. The personality level is how individuals can shape an environment because of their collective characteristics. In other words, the component of human aggregate is the unique culture that is jointly owned by all members of the school or an individual's attraction to and satisfaction with an environment (Huebner, 1989).

The "organizational measure" factor emphasizes on the teaching approach in a campus environment. It plays a very important role in the process of creativity, including the introduction of certain ideas and the atmosphere of teaching, such as the reward system that can stimulate students to be more active and creative. Therefore, the school organization level should encourage and support the teacher's creative performance. Mellou also believes that the creation of creativity must be stimulated by the environment, such as peer encouragement and enough space and time (Mellou, 1996).

The "social climate" factor emphasizes on the subjective views and the experiences of participant observers. Compared with the "human aggregate," this factor belongs to the psychological level of the campus environment (Strange, 2003). Social climate can be observed directly in the organization, the feelings of perception are not the same because of the environment in different personal conditions (Isaksen, 2001). The interaction between member's motivations and themselves, etc.

The "physical component" factor emphasizes on the campus environment, it refers to the tangible, or material, objects and conditions that surround our lives, which can be divided into natural and man-made environment (Amabile, 1988).

Findings

In this study, structural equation modeling (SEM) was used with AMOS 18.0 and SPSS 18.0 as software to test the hypotheses. Table 1 reports the eigenvalues and the Cronbach's α to show reliability of the questionnaire. Table 2 presents the factor loading of the items. In the results, all 26 items can be divided into four part, and were corresponding to the four factor (construct). The first factor is human aggregate (HA), this scale consisted by 4 items (M=3.71, SD=.947), indicated the degree that students felt their creativity is influence by the campus culture or the organizational style. The second factor is organizational measure (OM), this scale consisted by 7 items (M = 3.77, SD = .896), indicated the degree of participants' perceptions influence from the way of leading by their teacher. The third factor is social climate (SC), this scale consisted by 8 items (M = 3.55, SD = .823), measured the extent of which students reported being influenced by the atmosphere of the class and the interaction between them. The fourth factor is physical component (PC), this scale consisted by 7 items (M = 3.43, SD = .93), measured the degree that students felt their creativity can be stimulate by the facilities in environment.

Table 1
Eigenvalues and Cronbach's α of environment factors

Environment factors	Eigenvalues	Cronbach's α
Human aggregate	1.775	.567
Organizational measure	5.031	.714
Social climate	1.630	.607
Physical component	2.308	.638

Table 2
Factor loading

Items	*HA*	*OM*	*SC*	*PC*
Human aggregate:				
The instructor respects individual differences.	*.65*			
The school usually encourages students to freely use their imagination.	*.59*			
The school encourages students to put their imagination into practice.	*.66*			
I think the school's learning environment has provided a beneficial effect on my creative thinking.	*.08*			
Organizational measure:				
The instructor usually uses encouragement and praise to supervise.		*.74*		
The instructor provides us with plenty of equipment and resources.		*.62*		
When we make mistakes, the instructor usually reprimands us.		*.15*		
During the design process, the instructor always provides guidance and explanation.		*.68*		
The instructor gives us opportunity to solve the problem independently.		*.22*		
The instructors often share personal or other people's experiences.		*.70*		
During the discussing, the atmosphere between instructors and us is harmonious and pleasant.		*.48*		
Social climate:				
When I work in the team, I am more able to have innovative ideas.			*.49*	
In the team, the atmosphere between the team and me is pleasant and not too restricted during the discussions.			*.28*	
I usually communicate and discuss with team members.			*.55*	
I think my team members are often not active.			*.18*	
I am willing to accept new challenges.			*.48*	
During a class or meeting, I take the initiative to ask questions.			*.30*	
Between my classmate and I, we have a healthy competition with each other.			*.50*	
The instructors often support by our ideas.			*.45*	
Physical component:				
When I meet with the instructor, there is space for discussion (such as a seminar room).				*.51*
Through dynamic visual stimulation (such as rhythm, sound and film), my creative ideas can more easily emerge.				*.00*
Through static visual stimulation (such as content, composition and image), comparison can make my ideas emerge.				*.61*
I like to think in a quiet place.				*.63*
I can stay attentive in a noisy environment.				*.45*
I often stay in a neat open space.				*.58*
The instructors usually use videos or slides to coach.				*.36*

Overall, the results show that the human aggregate has the most greatest effect to stimulate students' creativity, followed by organizational measure and physical component. It means the result suggest that more encouragement and respect can has a positive influence on students' creativity. The organizational and physical environment such as interaction, guidance, space, and facilities, are also have a positive effect.

The result of hypothesis model ($\chi 2/df = 1.573$, GFI = .882, RMSEA = .061, NFI = .723, CFI = .872) and path analysis are as shown in Figure 2 and Table 3, the hypothesis of *H1a* and *H1b*, it is indicative that human aggregate has a significant positive effect on both organizational measure and physical component. Thus, to enhance a student's creativity, a creative campus culture needs to be developed through the creativity by teacher's teaching methods and the physical resources applied to students learning. For the hypothesis of *H2a* and *H2b*, it is shown that physical component has a significant positive effect on both social climate and organizational measure, which means the physical component, such as hardware resources may directly influence both students and teachers by like encouragement (OM) and competitive (SC).

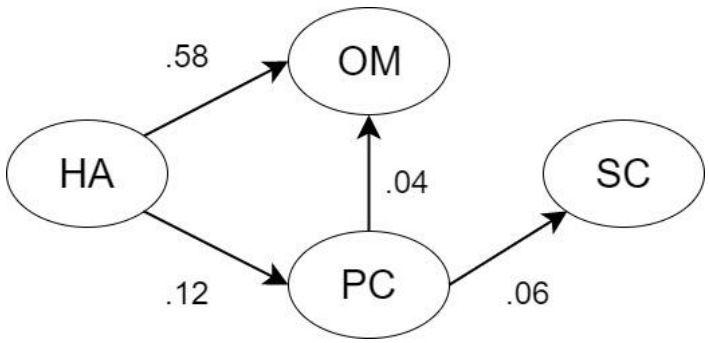

Figure 2. The correlation coefficient of hypothesis model

Table 3
Result of Path Analysis

Hypothesis	Path	B	SE	Z	P
H1a	HA→OM	.455	.076	6.026	*
H1b	HA→PC	.282	.057	4.943	*
H2a	PC→SC	.508	.081	6.254	*
H2b	PC→OM	.489	.103	4.760	*
H3	HA→PC→OM	.138	.040	3.425	*

*P<0.01

In the mediation effect *H3*, it can be seen that the direct effect of human aggregate on physical component (z = 4.943) and physical component on organizational measure (z = 4.760) are significant (P<0.001). Human aggregate has a significant indirect effect on organizational measure through physical component (z = 3.425), and the direct effect of human aggregate on organizational measure (z = 6.026) is also significant, it means that physical component is a partial mediator among human aggregate and organizational measure. It means that in campus, the promotion of policies and campus atmosphere will contribute to the quality of physical composition, thus affecting the development of teacher's teaching.

Discussions

In the survey results, some of the hypothesis in the previous hypothesis model are not suitable for students in the CSIE department. Due to limited human resources and financial budget, the number of samples was small and limited to only one school, i.e., the National Chung Cheng University, thus the study may not correctly reflect all CSIE students at

different levels of academic performance. Therefore, we put forward research recommendations for future researchers, suggesting that future researchers can increase the number of samples by investigating more schools for data processing and analysis, so as to have a higher degree of credibility and reference value.

In addition, this study is also limited by the lack of time, so the empirical research is based on cross-sectional data collection as a basis, instead of a longitudinal survey method that can better explore the causal relationship between variables. In the future study, it is recommended that researchers can discuss with experts of pedagogy and use longitudinal cross-sectional surveys to conduct long-term observational studies.

Conclusions

In this section, we will make some recommendations based on the analysis result, in order to help schools with more effective and more attractive ways to promote students' creative thinking.

Improve response measures for different groups

Policies that respond to different groups can improve the way students think. For example, in the analysis results, human aggregate has a positive impact on organizational measure through the physical component, showing that if the campus culture gives a different way of teaching to the undergraduate students (such as film), or gives graduate students enough personal space to think, it will be able to effectively enhance the students' creative thinking.

Enhance the learning quality

Giving a suitable discussion space to students can provide opportunities for them to engage in self-thinking. Another way is to provide ample equipment to let them have more contact with new things rather than relying solely on the reward system, so that students can generate new ideas and will not be subject to the constraints of thinking.

Finally, since this study model only explores the constructs of human aggregate, organizational measure, social climate, and physical component, other factors that may affect creative thinking can be considered in the future, and future research is recommended to further study the impact of other factors on creative thinking.

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