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Influential Factors and Their Correlation on Student Imagination

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Abstract. This study aimed to analyze what influential factors could stimulate imagination of design students in different design phases and explore how these factors correlate with each other. The influential factors were categorized into two groups: environmental factors (i.e., physical component, human aggregate, organizational measure, and social climate) and psychological factors (i.e., facilitative motivation, generative cognition, positive emotions, inspiration through actions, self-efficacy, and stress/challenge). These effects are seen in the design process, especially in phase one (problem definition and design analysis) and with a lesser effect in phase three (detailed design and communication). Our results also showed that the social climate factor had a close relationship with the factors of positive emotion, stress/challenge, and self-efficacy. The correlation among the factors of stress/challenge, physical component, and human aggregate deserved additional attention, as those factors might have crucial implications to instructional strategies.

Keywords: design school students; environmental factors; imagination stimulation; influential factors; psychological factors

Introduction

In recent years, from Europe to the Pacific region, more and more outstanding design has emerged from Taiwan. Over the past five years, Taiwan's designers have won more than 100 awards from the four major international design competitions: Red Dot, iF, G-Mark, and IDEA. These achievements declare the power of design to the world. 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 is the driving force of innovation. The discourse on the values of imagination and imagery process is often neglected in Asia, but has become a focus of contemporary European scholars (e.g., Büscher, Eriksen, Kristensen, & Mogensen, 2004; Folkmann, 2010; Trotman, 2006).

There are limited studies, which have been published linking the learning aspects of environment and psychology to factors of imagination stimulation, let alone developed an assessment tool for evaluating imagination stimulation in the design field (Yueh, Chang, &Liang, 2013). The need for evaluating and having a greater understanding of these factors become more apparent when considering the importance between imagination stimulation and possible instructional strategies for design school students (Liang, Hsu, & Chang, 2013). In response to this need for research, this study aimed to analyze what factors influence students' imagination in different design phases and explore how these factors correlate with each other. In this study, "imagination" refers specifically to "the process of transforming the inner imagery of design school students when they face a design task." Such images are developed from the individual's image memory and shaped into something new.

Imagination studies

Dewey explained how imagination works a hundred years ago, "*Imagination is an aspect of reflective thinking that enables us to create ideas that not only go beyond what is given*" (Dewey, 1910, p. 7); "*Imagine as it reshapes experience are things which are absent in reality…. The variety of peoples and environment, their contrast with familiar scenes, furnishes infinite stimulation*" (Dewey, 1916, p. 60, 212); "*… the conscious adjustment of the new and the old is imagination*" (Dewey, 1934, p. 272). These quotes show that imagination can change old, familiar experiences to new insights or actions.

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 in their imagery. It is possible to demonstrate this experimentally for many types of creative discoveries (Finke, 1990; Liang &Chia, 2014). Therefore, imagination can be viewed as the basis for cultivating creative thinking, and thus is the driving force of innovation (Finke, 1996; Policastro& Gardner, 1999).

Reichling (1990) held that intuition, perception, thinking, and feeling recur throughout the various conceptions of imagination. She defined intuition as a quality aligned with thinking but distinct from reasoning. Bower et al., (1990) perceived intuition as an informed judgment in the context of discovery.Specifically, clues to coherence automatically activate the problem solver's relevant mnemonic and semantic networks. Wippich (1994) contended that a more fluent reprocessing of coherent stimuli could be a basis for intuitive judgments. Bolte and Goschke (2008) further indicated that intuitive gestalt judgments for coherent fragments rested on the activation of semantic object representations, which biased participants' intuitive impression of gestalt.

Moreover, Reichling indicated that perception serves as a mediated mode of knowing. Perceptions and intuitive knowledge are made recognizable through experiences. Experience is phenomenologically and existentially construed to include what is actually experienced as well as the undergoing of an experience.

O'Connor and Aardema (2005) situated imagination within the consciousness complete with its own precognitive, cognitive, and meta-cognitive domains. They argued that divisions between perception and imagination are transcended by precognitive factors and believed absorption in a possible world depended on the relationship between core and marginal consciousness.

Another facet of imagination identified by Reichling is "thinking."Finke (1990) introduced the concept of "pre-inventive forms" into the operations of creative thinking, and described an approach to creative invention differing from those typically used in problem-solving studies. After discussing three extant views of mental imagery (quasi-pictorial, description, and perceptual activity theories), Thomas (1999) concluded that the traditional symbolic view of mental contents should be rejected, while the situated cognition and active vision approaches are preferred. Thomas thus viewed imagery as non-discursive, and related it closely to seeing.

Reichling contended that feelings are another crucial facet of imagination. Goodman (1985) claimed that emotion in an aesthetic experience is a means of discerning what properties a work has and expresses. Scheffler (1986) believed that emotions serve as a cognitive stimulus to the scientific imagination. Cognitive emotions are a source of imaginative patterns and perform a selective function among these patterns. Berenson (2010) concluded that feelings allow the inner leap in an individual's imagination. Feelings also serve as the basis bringing forth the exhilaration of discovery.

Environmental factors

As the American College Personnel Association (1994) indicated, an understanding of any human environment begins with the identification of its essential features: its physical component and design, its dominant human characteristics, the organizational structures that serve its purposes, and the participants' constructions of its social climates. These dimensions create a variety of conditions on campus, and can enhance or detract from student learning and development (Liang et al., 2013).

At first, the *physical* dimension of a campus consists of its natural environment (location, topography, weather, temperature, etc.) and its man-made environment (architecture, sound, spaces, facilities, and messages sent to its inhabitants). The major components of a physical environment include: ambient environment, environmental load, personal space, privacy, territories, and crowding (Gifford, 2007; McAndrew, 1993). Secondly, the *human aggregate* dimension is the collective characteristics of people who inhabit the environment. These characteristics stress the uniqueness of the organization and provide a sense of belonging for its members. The human aggregate represents a school's intangible property: school history, philosophy of education, traditional values, ritual practices, special events, school images, shared beliefs, and behavioral norms (Huebner & Lawson, 1990; Peterson & Spencer, 1990).

Thirdly, Strange (2003) indicated that the complex nature of universities results in the need to maintain a sense of order and generate various arrangements that define the *organizational measure* 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. Such organizational measureswould affect the performances of any organization in terms of innovation, efficiency, and morale (Hage, 1980). Lastly, 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 and Banning, 2001, p. 86) Environments can also be described in terms of their personalities, or social climates, which are composed of relationships, personal growth, and system maintenance (Moos, 1979).

Psychological factors

Accordingly, psychological aspects of imagination stimulation would include factors of facilitative motivation, generative cognition, positive emotion, inspiration through action, and self-efficacy (e.g., Gallese, Keysers, &Rizzolatti, 2004;Garcia, McCann, Turner, &Roska, 1998; Hennessey, 2003; Liang,& Chang, 2014; Liang, Chang, & Hsu, 2013; Lin, Hsu, &Liang, 2014; O'Connor &Aardema, 2005). As students enter college and gain greater autonomy over when, what and how they study, Ford (1992) indicated that *motivation* is crucial in guiding the direction, persistence, and quality of their learning behaviors. According to action-control theory, volition plays a critical role between the motivation to learn and goal-directed behaviour (Garcia et al., 1998). Hennessey (2004) also held that there is a direct relation between the motivational orientation brought to a task and the likelihood of creativity at that task.

Generative cognition is associated with the learner's perceptions, feelings, and other ways to trigger ideas; e.g., using multiple representations or mental simulations (e.g.,Taylor, Pham, Rivkin, &Armor, 1998). Gallese et al. (2004) claimed that a direct experiential grasp of what other people do or feel is intrinsic to human nature. This experiential insight into other minds provides an important view for generative cognition. In addition, Miserandino (1996) identified evidence of engagement within a school as energized behavior (e.g., initiation, effort, concentrated attention, persistence) and *positive emotion* (enthusiasm, happiness, curiosity, interest, etc.) (p. 204). Fredrickson (2001) also suggested that positive emotions broaden a person's available repertoire of cognitions and actions, thus enhancing creativity. Hennessey (2003) even indicated that the undermining of creativity in performance may be largely driven by an affective, rather than a cognitive mechanism.

O'Connor and Aardema(2005) contended that imagination and perception constantly operate together to form any kind of awareness. Fredrick (2007) confirmed that the most effective and creative problem solvers engage in a process of *meta-thinking* in which people are aware of how they are thinking as they are thinking. Therefore, Fukasawa claimed that the true essence of design is the revelation that occurs when realizing something about an object during its

use that was not noticed before(Goto, Sasaki, &Fukasawa, 2004). Furthermore, Bandura (2000) indicated that people of high efficacy would focus on the opportunities worth pursuing, and figure out ways of exercising some control even in environments with many constraints. Clark (1998) confirmed that individuals tend to be more motivated to reach a goal if they had strong self-efficacy beliefs. Yong (2010) concluded that individuals with high self-efficacy perceive themselves as capable of taking the necessary steps to resolve problems.

Method

Participants involved in this study were students from twelve universities across Taiwan. They had to satisfy three requirements: Students had to be majoring in a design related department, have at least sophomore standing, and have similar assignments of graphic 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 design assignments. In other words, this study could be implemented cross campuses under a comparable timetable and similar design tasks.

The investigation process delivered in each university followed the same procedure. Each student participant received a cover page and a questionnaire in a package. In the cover page, all participants were informed that their involvement was voluntary and they could withdraw from the study at any point in time without incurring a penalty. Students were guaranteed anonymity, confidentiality, and the right to review the results of their responses. In the questionnaire, students were asked to determine the strength of influence that each identified item had on their imagination in the current design phase. Data collection of each survey was conducted by well-trained graduate assistants who were accompanied by the class instructor.

Although design and problem solving are compound processes that often include iterations or re-defining the problem in the reality. However, a systematic approach of instructional activities that allow students to gradually grasp complicated concepts is oftentimes needed. The questionnaire was thus distributed in three different design periods. The first period, the phase of problem definition and design analysis, was during the first two weeks of October 2012. The second period, the phase of concept development and prototyping took place in the final two weeks of November 2012. The third and final period, the phase of detailed design and communication, was during the middle two weeks of January 2013.

In the first phase, a total of 1,224 valid samples were collected, including 354 sophomores, 365 juniors, 332 seniors, and 173 in their master programs. In these subjects, there were 338 male and 886 female participants. 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.

Since measures of influential factors on stimulating imagination in different design phases were unavailable, new scales needed to be developed for this study. Based upon the literature review above and personal experience, items were created to represent the issues identified in this study. All the preliminary items were organized into two groups: environmental factors (i.e., physical component, human aggregate, organizational measure, and social climate) and psychological factors (i.e., facilitative motivation, generative cognition, positive emotion, inspiration through action, and self-efficacy). In order to make the standpoints of the participants clearer, items were measured using 4-point Likert scales, ranging from 1 to 4. Higher scores indicated higher levels of influence.

The items were examined for comprehensiveness and clarity by three research associates and a small group of graduate students. The constructed scale was pre-tested by 235 college students in the target pool and then verified by preliminary validation analyses. Based on satisfactory analytical results of the pilot study, a total of 53 items were chosen to construct the formal questionnaire. The measured items were organized by item analysis on the mean (2.54-3.69), standard deviation (> .75), skewness (< ±1), extreme value test results (p < .05, t > ±1.99), 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 reliable with Cronbach's alpha values of .912, .918, and .925 in the three different phases. The Cronbach'salpha value for each scale item was high enough (> .903) to warrant confidence in internal consistency reliability as seen in Table 1.

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

Demographical Data & α		Phase 1	Phase 2	Phase 3
N		1,224	1,002	968
Gender	Male	338 (27.61%)	303 (30.24%)	274 (28.31%)
	Female	886 (72.38%)	699 (69.76%)	694 (71.69%)
Standing	Sophomores	354 (28.93%)	260 (25.95%)	289 (29.85%)
	Juniors	365 (29.82%)	302 (30.14%)	306 (31.61%)
	Seniors	332 (27.12%)	308 (30.74%)	259 (26.76%)
	Master program	133 (14.14%)	132 (13.17%)	114 (11.78%)
Cronbach's α	Whole	.912	.918	.925
	Item	> .903	> .914	> .923

Results and discussion

Factor analysis

Factor analysis results indicated that the 53 items could be organized into two groups and ten factors. The first group was the environmental aspect of influential factors, while the second was defined as the psychological aspect. The majority of factors were consistent with earlier studies (e.g., Gallese et al., 2004; Huebner et al., 1990; O'Connor &Aardema, 2005; Strange, 2003) except for the stress/challenge factor which was not identified as an independent stimulus in the literature. Within the environmental group, the four factors accounted for 50.80% of the variance in the phase one, 54.68% in the phase two, and 52.34% in the phase three. In the psychological group, the six factors accounted for 48.25%

of the variance in the phase one, 50.71% in the phase two, and 52.58% in the phase three.

Within the environmental group, the first factor emerged was *social climate*, a seven-item scale, which measured the extent of which learners reported being influenced by the class climate. This finding was consistent with early studies (e.g., Hennessey, 2004; Strange, 2003). The social climate factor was rated as the greatest influential factor in this study. Its effect in phase one appeared to be greater than the other two phases.

The second factor, *organizational measure*, a six-item scale, assessed learners' perceptions of the influence from the institutional structure and organizational measures. This result was also compatible with the literature identified earlier (e.g.,Hage, 1980; Strange, 2003). This factor was weighed as the most influential one by the subjects in phase two, which implies that this factor may be critical in developing related instructional strategies.

The third factor, *human aggregate*, a five-item scale, indicated the degree to which learners felt that their imagination was influenced by the organizational culture, tradition, or style. This finding lent additional support to previous research (e.g., Huebner & Lawson, 1990; Peterson & Spencer, 1990). The moderate effect caused by this factor was steadily generated throughout the three phases.

The fourth factor, *physical component*, a six-item scale, measured the degree to which learners considered the facilities and messages in an environment would stimulate imagination. This result also supported the previous studies regarding learning environments(e.g., Gifford, 2007; McAndrew, 1993). Although this factor had the least effect in the environmental group, its mean (3.09 average in three phases) was high enough to be considered influential.

Within the psychological group, the first factor identified was *positive emotion*, a three-item scale. This factor measured the extent of which learners reported being influenced by optimistic intentions. Our results provided supplementary support for early inquiries in this topic (e.g., Clark, 1998; Hennessey, 2003). The positive emotion factor was rated as the second greatest influential factor in this study. Its influence on phase one also appeared to be greater than on the other two phases.

The second factor, *facilitative motivation*, a four-item scale, assessed learner's initial driving force in knowing and learning. This finding was compatible to the classic theories of motivation (e.g., Garcia et al., 1998; Rosenbaum, 2002). The emergence of factors of self-efficacy, stress/challenge, along with facilitative motivation, showed the different effectsbetween intrinsic and extrinsic motivation on student learning and imagination stimulation. It should be noted that the effect of this factor dropped slightly in the third phase.

The third factor, *inspiration through action*, a five-item scale, examined how learners felt that their imagination was influenced by meta-thinking during

hands-on practice. This result supported the studies conducted by Goto et al. (2004) and O'Connor et al. (2005) regarding the integration of external reality with inner experience, as well as the interaction among perception, consciousness, awareness, and imagination. We found that the weight of this factor in the final phase was greater than the previous two phases.

The fourth factor, *self-efficacy*, a seven-item scale, evaluated the extent of which learners reported being influenced by the belief in their own competence.Our study was consistent with the modern studies of self-efficacy (e.g., Bandura, 2000;Yong, 2010). The emergence of this factor also lent support to the studies of mental simulation and anticipatory effects resulting from active perception proposed by Rosenbaum (2002). The weight of this factor in the third phase was greater than the previous two phases.

The fifth factor, *generative cognition*, a six-item scale, measured the degree to which learners considered what cognitive approaches would stimulate imagination. This finding was also consistent with the literature identified previously (e.g., Gallese et al., 2004;Taylor et al., 1998). The effect resulted from this factor was consistent throughout the three phases.

The sixth factor, *stress and challenge*, a four-item scale, indicated the degree to which learners felt that their imagination was influenced by one's psychological state and feelings regarding their surroundings. It should be restated that this factor was not originally identified as an independent stimulus in this study. However, several studies would support this finding. Accordingly, emotions experienced during cognitive processing of learning materials can be viewed as imposing unnecessary load in working memory, thus creating a negative effect on reasoning and performance.The effect of this factor on phase one was greater than the following phases. Although this factor had the least effect in this study, its mean (3.05 averaged in three phases) was high enough to be still considered influential.

The results of this study indicated that the five greatest influential factors, from most influential to least, were social climate, positive emotion, organizational measure, facilitative motivation, and inspiration through action. These effects are seen in the design process, especially in phase one (problem definition and design analysis) and with a lesser effect in phase three (detailed design and communication). The factor loadings, means and standard deviations are reported in Table 2.

Table 2: Means and standard deviations of each factor in three design phases

Group/Factor	Phase 1			Phase 2			Phase 3		
	Factor	*M*	*SD*	Factor	*M*	*SD*	Factor	*M*	*SD*
Environmental									
Social climate	.825	3.45	.452	.829	3.37	.471	.832	3.29	.478
Organizational measure	.789	3.41	.478	.816	3.38	.492	.744	3.28	.523
Human aggregate	.798	3.30	.531	.821	3.24	.535	.799	3.19	.524
Physical component	.736	3.18	.458	.779	3.13	.492	.787	3.08	.492
Psychological									

Positive emotion	.609	3.39	.490	.655	3.31	.522	.663	3.29	.544
Facilitative motivation	.511	3.37	.412	.632	3.33	.452	.715	3.23	.501
Inspiration thru action	.634	3.29	.423	.646	3.24	.423	.725	3.24	.473
Self-efficacy	.696	3.17	.424	.743	3.20	.444	.773	3.17	.454
Generative cognition	.619	3.12	.395	.646	3.12	.395	.743	3.05	.445
Stress and challenge	.627	3.10	.533	.604	3.01	.532	.638	3.01	.527

Correlation

Pearson correlations were conducted to see how the influential factors correlate with each other. The statistics for the whole process are reported in Table 3:

1. Significant correlations were found among all factors in the whole process. The correlations showed moderately strong correspondence (r> .4) between the social climate (SC) and positive emotion factor, SC and self-efficacy factor, and SC and stress/challenge factor. These results were compatible with the organizational climate literature (e.g., Hennessey, 2004; Strange, 2003) which viewed the climate as a critical factor in affecting people's psychological status. This study suggests thatdesign instructors should pay attention to the interlacing influences caused by social climate, positive emotion, self-efficacy, and stress/challenge factors, and seek an integrative instructional strategy to take these factors into account.
2. In the first phase, statistics showed that there was a significant correlation between environmental and psychological factors (r = .613, p< .001). Specifically, correlations between SC and positive emotion factor, and SC and stress/challenge factor approached a moderate level. This finding implies that instructors need to focus upon the social climate related strategies during the initial design phase.
3. In the second phase, there was a significant correlation between environmental and psychological factors (r = .623, p< .001). Significant correlations between factors of SC and positive emotion, SC and self-efficacy, SC and stress/challenge, andorganizational measure and positive emotion also approached a moderate level. These results suggest that instructors might further promote students' self-efficacy and positive emotion by utilizing a combinational approach of social climate and organizational measure factors in the second phase.
4. In the third phase, we found that there was a significant correlation between environmental and psychological factors (r = .668, p< .001). Significant correlations between factors that reached a moderate level included SC and positive emotion, SC and facilitative motivation, SC and inspiration through action, SC and self-efficacy, SC and stress/challenge, organizational measure and self-efficacy, human aggregate (HA) and positive emotion, HA and self-efficacy, and HA and facilitative motivation. In addition to implementing socially-constructed related strategies, our results suggested that instructors might need to add extra strategies related to organizational measure and human aggregate in the final phase.

Due to the complexity of correlations in each design phase, canonical correlation analyses were conducted to ascertain the meanings of these relationships.

Table 3: Pearson correlations among influential factors on imagination stimulation

Factor	1	2	3	4	5	6	7	8	9	10
1. Social climate	1	.599***	.606***	.455***	.465***	.389***	.361***	.437***	.308***	.457***
2. Organizational measure		1	.561***	.484***	.395***	.381***	.323***	.386***	.272***	.318***
3. Human aggregate			1	.419***	.369***	.358***	.321***	.377***	.295***	.274***
4. Physical component				1	.329***	.338***	.299***	.362***	.305***	.270***
5. Positive emotion					1	.376***	.297***	.362***	.257***	.381***
6. Facilitative motivation						1	.391***	.371***	.383***	.320***
7. Inspiration thru action							1	.421***	.427***	.294***
8. Self-efficacy								1	.338***	.392***
9. Generative cognition									1	.238***
10. Stress and challenge										1

*p<.05.**p <.01.***p <.001.

A canonical correlation analysis (CCA) was further conducted to see if influential factors shared a substantial variance showing that they could be used as supplements or complements. CCA examines the correlation between two synthetic variables that are weighted based on the relationships between the variables within the sets. CCA thus can be conceptualized as a bi-variate correlation (Pearson *r*) between the two synthetic variables, which are created from the equations of canonical functions (Sherry & Henson, 2005). Since CCA is founded on the Pearson *r*, the correlations calculated from the first function are usually similar to the results of Pearson *r*. Therefore, the point of interest lies mainly on the results of the second function on the whole process and each individual design phase.

The analysis for the whole process yielded two functions with canonical correlations (R_c) of .666 and .197. Looking at the Function 1 coefficients, significant correlations were found among all the factors, similar to the analyses of the Pearson *r*. The Function 2 coefficients showed that the stress/challenge factor was positively related to the social climate factor, but negatively related to physical component and human aggregate factors. These results confirmed that the class climate (social climate) was one of the main sources of stress and challenge. However, appropriate arrangements of facilities and messages within (physical component), and class and school culture (human aggregate) could be perceived and utilized as de-stressors for design students.

The canonical analysis for the three phases also yielded two functions respectively, with R_c of .640 and .211 in phase one, .657 and .216 in phase two, and .694 and .170 in phase three. The correlations resulting from Function 2 of each phase also showed that stress/challenge was positively related to social climate, but negatively related to physical component and human aggregate in all three phases. It should be noted that the coefficient of physical component dropped, and thecoefficientof generative cognition increased in the second phase. Interestingly, the coefficient of physical component continually went down in the final phase. Our results indicated that effects of physical component as a de-stressor constantly dropped along the design process, as the participants became familiar with the learning environment. Based on these findings, instructors should demand a contextualized approach of instructional strategies

which take all the environmental and psychological factors and their effects into account based on the emerging needs of different design phases.

Closing Remarks

Taken together, our results concluded that influential factors not only had significant effects on stimulating imagination, but also had varying effects during the three phases of design process. Specially, the factors of social climate, positive emotion, organizational measure, facilitative motivation, and inspiration through action,served as the most influential dimensions. The effects of these five factors were apparent, especially in the first phase (problem definition and design analysis). This phenomenon was also observed with the other factors. This implies that a set of unique instructional strategies applied during phase one could be particularly beneficial to design school students. The results also echo the study done by Büscher et al. (2004) in which work environment, tools to be used, and the nature of the task are sought out to form the best combinations for designers to utilize their imagination.

Ignorance is valued as a necessary precursor to curiosity. Curiosity, in turn, triggers imagination. Imagination is the process of transforming an individual's inner images. People construct new ideas from old experiences and develop their imaginations through their memories of images. The capability of imagination is a foundation for cultivating creative thinking, and is the driving force necessary for individuals to continually create and innovate. An excellent designer who is capable of simulating invisible possibilities is only able to because he or she has an exceptional imagination. We sincerely hope that design educators can use our study as a foundation to design appropriate and effective instructional strategies to inspire students' passion for excellence, nurture their curiosity, develop their imagination, empower their professional life, and awaken their spirit for unknown future.

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