CREATIVITY IN PRODUCT DESIGN EDUCATION: UNDERSTANDING THE LEARNING ENVIRONMENT

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ABSTRACT
This paper examines current research into the relationship between creativity and the immediate physical environment, and how it has been found to influence the creativity of undergraduate product design students. This includes conducting an experiment testing the familiar physical environment of the students, and exploring studies about how taking students into a different, more immersive environment affects learning and stimulates creativity.
By comparing the result of that experiment to theories about how environments can affect creativity, the score difference is not statistically significant overall even though one of the test groups scores marginally higher than the others. This outcome maybe occurs due to the type of experiment chosen, the scoring method or the test environments. The paper concludes by outlining plans for further investigation as part of a recently commenced PhD research project.

Keywords: Design, Creativity, Learning Environments, Learning, Enhancing, Physical Environment.

1   INTRODUCTION
Creativity is influenced by individual differences and environmental factors. Research shows that different people are creative in different circumstances [1]. The main purpose of this paper is to examine the potential role of the physical environment to foster creativity in Product Design Students. Many researchers have examined the relationship between environment and the learning process. For example, Groves et al. [2] looked at how creativity is fostered by both the built and cultural environment when they studied twenty of the most innovative companies around the world. In this study, they highlighted four important elements of the spaces in order to be creative: spaces that stimulate; spaces for collaboration; spaces for reflection; and spaces for play. Williams [3] in her research identified that different people found one or other of these spaces more effective in promoting their creativity. This paper discusses the current research context and then describes a research investigation in Cardiff School of Art and Design (CSAD) into product design students' creativity.

2   UNDERSTANDING THE LEARNING ENVIRONMENT
To explain how to be creative, creativity must first be described. It is a widely defined term, but one of the most commonly agreed definitions by Sternberg and Lubart [4] is that it is the ability to produce work that is novel and appropriate. Csikszentmihalyi [5] defines it as a process that occurs when a person using the symbols of a given domain such as art, music, business or mathematics holds a new idea or figures out a new pattern, and when that novelty is accepted as included in that domain. Thus it comprises both the individual's inspiration and interaction with their sociocultural context.
Many recent researchers in the creativity field are examining factors that can enhance the creativity level in individuals and stimulate them to think more innovatively including the social and physical environment. For example, Sawyer [6] suggested that four factors affect creativity: The creative process, which is the process involved during creative work or creative thoughts; the creative product, as the result of the creative process; the creative person, defined here as one who generate creative products; and the creative Press, defined as the external factors or pressures acting on the creative person or process such as the social and physical environment. Fields and Bisschoff [7] identified 11 creativity influences from literature and through practical experiments. Space, time, cost and colour are some of the most effective influences identified. Some studies offer spatial suggestions towards enhancing creativity in the classroom, for example, the effect of merging landscape within the classroom environment is a commonly discussed subject e.g. Thoring et al's [8] work which examines

the relation between landscape and creativity. Engaging with the environment may enhance the ability to be creative, whereas distractions may reduce that ability. Loud noises, for instance, lead to reactions and can certainly be distractions [9]. In education, creativity is more widely investigated in general learning rather than from the higher education perspective, e.g. the work of Bellanca and Brandt [10], and McLellan and Nicholl [11] who investigated the relation between classroom climate / environment and students' creativity. Researchers have explored the creative process over the past fifty years, but there is little clarity about the factors that enhance the creative abilities of individuals [12]. Fostering creativity within individuals is essential in the design learning process. So identifying such factors would benefit both the field of design, and the design learning process. Creativity in design education has also been related to teaching methods and learning theories, as in Runco [13] and Loudon et al [14]. It is held to be more convenient and effective to change conditions in the environment rather than trying to deal with their thinking in order to make them think more creatively [5]. The physical environment reinforces the support that the social environment provides for creative individual and groups [15]. Dul, Ceylan, and Jaspers [16] described the role of the physical environment on individuals and group creativity as the less directly identifiable but more strongly effective factor of all other factors. Csikszentmihalyi [5] identifies that choosing the wrong environment will hinder the unfolding of creativity, yet it remains questionable whether the right environment can be determined.

The type of learning environment is important for students' creativity. This supports the argument of Runco and Johnson [17], who state that creative development of students is largely dependent on the environment in which they exist. Loudon et al [18] highlighted how a change of physical and social environment might affect product design students' ability in learning new design skills and generating new ideas. The idea was to take a group of undergraduate product design students for a 6-day trip away from their city-centre based university location to the remote island of Tiree in the Hebrides of Scotland. As a result of this study, students were inspired by the rural landscape in Tiree and this had a positive effect on their creativity. Although the relaxed and inspiring atmosphere resulted in students being more relaxed while being there, this did not necessarily result in the generation of new ideas and design exploration. Loudon et al. argue that more key elements should be presented to students such as access to the necessary resources (time, training and tools) and the setting of challenging goals. Even though a Design Studio, which is commonly used at universities for teaching product design, provides a certain sense of a stimulating environment through play, prototyping and collaboration [ibid], there is a need to recognize other physical environments (such as being outside connecting with nature) that can also enhance a student's creativity via spaces for reflection. Even though the physical environment is important, there is limited scientific research on its effect on creativity [3]. It is the Press or the physical and social environment as it applies to higher education that is the focus of this study. While there are many complex views about the concept in general, comparatively little has been done on its application in higher education.

2.1 Torrance Tests of Creative thinking (TTCT)

E.P. Torrance created tests of creative thinking, which were later called TTCT. TTCT has been used in a wide variety of psychological studies and is accepted to be a good creative task of problem solving. Cramond et al [19] describe the history of TTCT building on Guilford's earlier work on creativity. The tests are designed to test aspects of creativity and originality through studies of divergent thinking. They are scored based on the type of test, either Figural or Verbal, on four scales of Divergent Thinking as stated by Cramond et al [ibid]: (a) Fluency—the number of relevant responses; (b) flexibility—the number of different categories or shifts in responses; (c) originality— the number of unusual yet relevant ideas as determined by statistical infrequency; and (d) elaboration— the number of details used to extend a response. It is argued that divergent thinking tests can be used as "estimates of the potential for creative thought" [13]. One form of test of the Physical Environment emerges from TTCT undertaken in a variety of learning environments through staged experiments supported by participant interviews and questionnaires.

As a result, the TTCT 30 Circle Test was chosen to examine with product design participants. It is a well-known figural test used to measure creativity and divergent thinking [20]. It is one of the TTCT figural tests described above, and is claimed to highlight the balance between Fluency and Flexibility. "The circle test" consists of an A4 answer sheet with 30 Blank Circles in a 5 x 6 rectangular pattern. Participants are instructed to see how many circles they can occupy as objects within three minutes.

3   METHODOLOGY

45 CSAD students from Cardiff Metropolitan University participated in this study. Participants were divided into three groups randomly in order to do "the circle test" as part of the TTCT. Each group was in a different environment to which they were assigned randomly within a monitored period of time. In this experiment, simple rules were given to the participants: (a) they were advised to occupy as many circles as they can; (b) no clues were given to the participants; (c) a circle must be part of their drawing.   A time limit of three minutes was given to finish, followed by a one-minute questionnaire to evaluate the test environment and their feelings towards it.   The participants were from a similar level of education (Level 4 and 5) and from the same field of study with the same age range. Gender was not a matter of consideration as the environment was the variable factor in this test. Each environment has its characteristics and atmosphere as will be shown later. Participants in Group 1 were seated in the CSAD 'Heart Space' (communal area) at lunchtime when it was as busy as it could be during the daytime; participants in Group 2 were in their Product Design Studio, which is also located in the CSAD building; and participants in Group 3 were in a Teaching room in the Management Building.

Table 1. Participants' details

Environment	Participant Number	Order in taking the test
Heart Space	16	1
Design Studio	16	3
Management Building	13	2

Each Participant received the same guides and directions in order to permit the same range of understanding among all the participants. The test was evaluated using the Consensual Assessment Technique (CAT) [21]. The participants were asked not to explain the meaning of this experiment to the other groups. Results of this experiment are discussed below. Some of the participant's results (6 ex 45) were excluded from the evaluation for not meeting the expected criteria e.g. no objects were drawn or they contained scribbles without any structure or meaning.

3.1 Participant Group 1: Heart Space in CSAD building

The 'Heart Space' in the CSAD building was chosen because it has an informal atmosphere, which gives the participants more flexibility in the way they seat and position. It was also a very busy space at the time the experiment was conducted, as it was 1:30 PM, i.e. lunch break.

Figure 1. Participants in Group 1 at the Heart Space in CSAD, as First Test Environment

Figure 2. Participants while conducting the experiment in the Heart Space

3.2 Participant Group 2: Product Design Studio

The main reason behind choosing this environment was the students' familiarity with the atmosphere. The students spend much of their time in the design studio. At the time of the experiment other sessions were running for other level groups of Product Design students, which may have caused distraction.

Figure 3. Participants group in the Design Studio

Figure 4. During the test in the Design Studio

Figure 5. Typical classroom environment

3.3 Participant Group 3: Teaching Room in Management Building

The management building is an unfamiliar environment for students from CSAD. The seating arrangement is very different to that they are used to. The seating was fixed and not flexible for participants to modify on their own as in the previous two test environments.
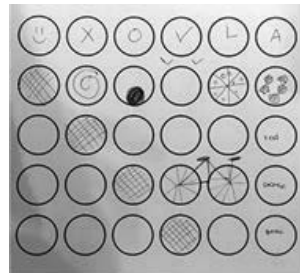

Figure 6. Example of the test result

After the tests, participants evaluated the test environment by questionnaire where they reflected on their feeling towards the test itself and its level of difficulty, their thoughts about the effect the test environment had and their feelings during the test.

In order to evaluate the result from the experiment, scores on both fluency and flexibility were given on the participants' results, with extra points for originality. This method didn't give accurate results, as it was hard to apply. Therefore, the Consensual Assessment Technique (CAT) was applied. CAT is a subjective method to determine general measures of assessment and refined by Amabile [1] as an approach for assessing creativity in experimental settings in terms of social and environmental effects. The technique has been expanded to a range of products and tasks extending to persons and processes as it was initially designed for use with artistic products [22]. The CAT has been extended to other domains, with associations of educational settings [1] and in relation to higher education [21]. The assessment of the experiment was assigned to 15 experts in the field of Art, Design and Creativity, to evaluate the results based on their experience. Experts evaluated the results by giving score 1:5 to each participant (5 is highly creative, 1 low creative) based on the originality of the generated objects.
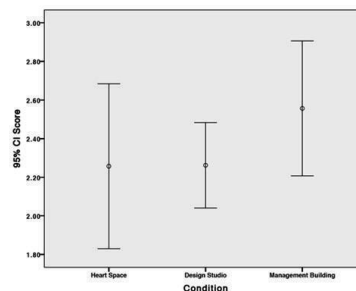

Figure 7. Statistical analysis of differences between the average creativity scores

4   ANALYSIS OF RESULTS

During the experiment it was noticed that some of the students were not fully engaged with the task as they were trying to engage with each other even though they were instructed not to. Although the instructions given alongside the test were the original instructions created by Cramond et al [19] they were not clear for some of the participants. The type of questions that were asked by the participants were similar and mostly about the limitations of created objects or about the quantity of the objects they can create.

After analysing the results, it became clear that the participants' originality was similar in the selected environments as the average score overall is 2.36. It is noted that the average score from participants from group 3 of 2.56 is marginally higher than the other two environments, however the difference is not statistically significant as shown in figure 6. In addition, the result of the questionnaire conducted to evaluate the test environment showed a similar result as the experiment with a same result in all environments. The reason for the similar results could be because the three environments were not sufficiently different; that differing environments do not affect creative performance; or the data collected was insufficient.

It could also be because the 30 Circle test given was too simplistic in nature to test creativity. It might have been better to conduct other TTCT tests alongside the 30 Circle test in order to provide more valuable information [23]. It was also found that the CAT method for measuring creativity is based on subjective judgments so it is difficult to rate. Students were not fully engaged with the environment which could effected the results, as Amabile (1) linked creativity in a task to the passion of doing it in the first place. A somewhat surprising result was that the management building teaching room had a marginally better creative score compared to the other environments, as shown in the table below. One reason could be that the teaching room had fewer distractions and this allowed for higher levels of concentration.

Table 2. The environment creativity score based on CAT

Heart Space	2.26
Design Studio	2.26
Management Building	2.56

5   CONCLUSION

This study has raised more questions about the possible role of the physical environment on the product design students and their creativity rather than answer them. For example, are reducing distractions more important than providing a stimulating, relaxing environment?   In future experiments the physical environment will be tested with different methodologies in order to look into these aspects in more depth. The plan is to also conduct more than one TTCT alongside each other in order to compare the result and test the effect of the environment. Conducting a more carefully structured and managed experiment with consideration of participant condition and level of engagement is expected to provide some clarification. It may also be beneficial to explore other methods to examine creativity rather than just the TTCT.

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