Creativity in Design: A Cross-Disciplinary Approach

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ABSTRACT

The issue of creativity in design was studied within two very diverse disciplines at the University of Kentucky. These disciplines were: Civil Engineering and Interior Design. These two disciplines were selected for their vastly different styles of creativity in practice and pedagogy. The study had two phases. The first phase was to assess the creativity of the freshman class in both disciplines. The second phase was to expose a subset of the students to a series of creativity training modules and assess any shift in their creative abilities. To accomplish this, a statistically valid experiment was designed using "control" and "treatment" groups within each discipline. The data demonstrated improvements in some categories of creativity. This improvement in the creativity index was possible as a result of a special creativity-training module. Future work will include larger pool, and longitudinal creativity studies.

I. INTRODUCTION

The premium placed on fostering both critical and creative thinking has increased in the last decade. Calls for creative solutions to problems are becoming ever louder and more insistent in this era. We are witnessing a concomitant resurgence of scholarly interest in creative thinking and creativity in fields such as psychology (Amabile, 1983; Cskszentmihalyi, 1997; Gardner, 1998; Sternberg, 1988) and business (Amabile, 1997, 1998; Kao, 1997). While the scientific as well as fine arts communities have long valued the original and creative individual, the business community increasingly urges their employees to "think outside of the box." The business world recognizes that creativity offers a competitive edge in a workplace that is characterized by complexity, change, diversity, and globalization (Kao, 1997). Paradoxically, however, standard business practices inhibit creativity and managers who report valuing creativity often do little in practice to support innovation (Amabile, 1998).

A parallel situation is present in post-secondary institutions where disciplines such as engineering and interior design place a premium on creative problem solving yet do little to structure their curricula or offer experiences that explicitly foster creativity. Capstone engineering courses often require creative problem solving but this may be difficult for students who are not schooled to think innovatively. Gardner (1998) describe four engineering faculty from Stanford University, Rensselaer Polytechnic Institute, Kettering University, and Purdue University who are attempting to reverse this trend and explicitly teach aspects of creativity in their classrooms. Their ideas and processes appear innovative but the general effectiveness of these pedagogical practices is unknown since only anecdotal evidence is provided on star student performers. The question of how their interventions impact different types of student learners remains unanswered.

II. Engineering and Design Programs

Program accreditation in engineering and allied design disciplines requires evidence that students can solve open-ended problems. Indeed, the National Accreditation Board, the Landscape Architecture Accreditation Board, and the Foundation for Interior Design Education and Research all require evidence of student creativity. Accreditation criteria in engineering (ABET Criteria) strongly suggest that colleges of engineering develop ways to measure and enhance creative problem solving. The Creativity in Design project employed the outcomes-based approach and assessment methodology espoused by the ABET philosophy.

The authors believe that calls from disciplines for an increased ability to solve problems creatively must be answered with instructional strategies informed by a research base, differentiated view of creativity, the creative process, and creative individuals. Sprinkling brainstorming activities throughout a curriculum may well increase the creative "fluency" of an individual, but such activities remain narrowly focused, ignoring the real complexities of the creative process as well as individual and disciplinary differences.

Through detailed case studies that present the engineering involved in products ranging from paper clips to building systems, Petroski (1996) postulates that engineering involves more than technical knowledge and expertise. Petroski makes the case for developing creativity in engineering thinking: "Mathematics and science help us to analyze existing ideas and their embodiment in 'things' but these analytical tools do not in themselves give us those ideas. We have to think and scheme about nature and existing artifacts and figure out how they can be altered and improved to better achieve objectives considered beneficial to humankind". Furthermore, the likelihood of creative breakthroughs multiples when both the structural or purely technical aspects of a problem and the larger aesthetic, economic, and social value questions are addressed.

The plan in this study was based on the premise that aspects of creativity in engineering and design can be taught and learned. Creativity in these disciplines involved both adaptation and innovation, doing things better and doing things differently. Engineering and design fields share an interest in materials and technology and operate within problem constraints. While the approach to working with materials and technology can be quite different, the value placed on creativity can be enhanced by interdisciplinary collaboration, echoing Perkins (1988) assertion that when disciplinary boundaries are crossed so too does the possibility for invention.

Faculties often assume their students develop skills in creative thinking implicitly as a result of performing in their curricula. Students, however, may struggle with creative problem solving. This frustration seems to be exacerbated when students are assigned open-ended design problems containing technical criteria or constraints.

Students and faculty may differ in their understanding of creativity in ways that relate to individual differences and to disciplinary cultures. Such differences may well require specific instructional methods (Davis, 1993; Philips, 1995). For example, techniques and practices employed to foster creative thinking are chosen and implemented depending on how creativity is defined and understood by both the instructor and the student. If creativity is seen to be an innate ability, implicitly understood as a “genius model,” then the chosen pedagogy will most likely involve motivation and provocation. On the other hand, if creativity is seen as a skill, something that can be taught, the educational objectives include the practice of these skills.

Not only may individual perceptions of creativity differ, but also differences exist among disciplinary cultures. Sternberg (1985) found, for example, that art professors emphasize originality, imagination, and experimentation while those in physics focused on finding order in chaos and the ability to challenge basic principles. MacKinnon (1962) also distinguished between artistic creativity that reflects externally defined needs and goals existing outside the individual (such as established principles). Such variations have pedagogical implications.

Two very different disciplines at University of Kentucky were selected for this study. The Civil Engineering (CE) and Interior Design (ID) departments at UK were selected because of their very different perspectives in practice and pedagogy, while at the same time they share a common emphasis on design. The focus of the study was placed on the freshman students. Both CE and ID disciplines at UK have an introductory professions course. The students in these two introductory professions courses were included in this study.

III. DESIGN OF EXPERIMENT

The experiment was designed to be statistically sound. This was achieved by having “Control” and Treatment” groups. Additionally, the experiment was replicated in the Civil Engineering (CE) and the Interior Design (ID) programs at University of Kentucky.

The CE and ID introductory professions courses were selected for this study. These two classes were divided into two sub-groups, called: Control and Treatment. The

Control groups in both classes were subjected to the regular course content without any change. While the Treatment groups were subjected to a modified course content, which included discussions about creativity styles, and creativity enhancing exercises.

IV. Creativity Training Module

The instructional module included adapting creativity techniques and analysis of practical design problems, which were applicable to both CE and ID disciplines. The students were exposed to alternative creative processes by participating in standard creative thinking enhancement techniques such as brainstorming, attribute listing, morphological synthesis, and creative dramatic that have been adapted by the project researchers to Civil Engineering and Interior Design. The researchers also incorporated promising techniques and strategies gleaned from the Stanford University Workshop on Creativity in Engineering Education program and the Institute on Creative Problem Solving.

Focus on the creative product and place occurred through an examination of 20th century classic chair designs that express innovative interpretations of form, material, design, and advances in technology. After each experience, inter-disciplinary dialogue occurred as CE and ID students considered issues related to creativity. The centerpiece of the instructional module focused on activities revolving around the design of a chair. This industrial design problem, utilizing esthetic as well as functional criteria, invites a wide range of creative responses. The design of a chair embodies dimensions of physical comfort and materials, aesthetics, economics and technology (Fiell & Fiell, 1997). As the manufacturing of chair progressed from the craftsmen to that of industrialization, a base of engineering and design knowledge was necessary to pioneer innovative chair designs within the constraints of modern manufacturing technology. Marcel Breuer (Wilk, 1981), for example, introduced cantilevered tubular steel frames into his chair designs and thus permitted a revolutionary continuous supporting frame that eliminated the visual clutter of four legs. The students also viewed and reflected on a videotaped documentary of concept functional, and manufacturing considerations in creating an ergonomically correct office chair (i.e., Sensor Chair by Steelcase, Inc.). There were other creativity training books and tapes that were available as resources to the students during the design project phase of the training module.

V. Assessment

A critical part of this research was assessment. In this regard, all students (all Control and Treatment groups) were subjected to a “pre-test” prior to the beginning of the course. Additionally, at the end of the course, all students were subjected to a “post-test”. The creativity assessment test used in this study was the Torrance Test for Creative Thinking (TTCT, Torrance 1979). This instrument is widely used by researchers and educators who employ creative process tests. The TTCT tests have standardized administration and scoring. According to Torrance, a high level of creative achievement can be expected consistently only from those who have creative motivations and the skills necessary to accompany the creative abilities. Four distinctive categories of the TTCT (Elaboration, Fluency, Completeness, and Originality) were used in this study. The TTCT scores associated with these four categories were statistically analyzed.

The pre-test was based upon the TTCT-Form-A, and the post-test involved using the TTCT-Form-B. Various comparative statistical analysis tools were used to quantify any significant effects. The following conclusions were made based upon an extensive statistical analysis of the TTCT scores for the CE and ID students. There were 50 students in the Introduction to Civil Engineering class, and there were 60 students in the Introduction to Interior Design class. These two classes were equally divided into the Control and Treatment groups in a random fashion. The average of these scores are presented in Figures 1 and 2. The following is a list of some conclusions that could be drawn from statistical analyses. Table 1 presents a summary of statistical comparisons that led to these conclusions.

1. There was no significant difference in the degree of difficulty between Forms A and B of the TTCT.
2. There was no significant difference between the TTCT creativity scores of Control, and Treatment Groups.
3. Replicating items #1 and #2 above in the CE and ID programs led to the same conclusions.
4. There appears to be an improvement in some creativity indices in CE and ID disciplines as a result of the creativity training.

Table 1. Summary of Statistical Comparisons (ANOVA).

ANOVA Comparisons	Significant Difference at 5% Error Rate
CE-Control-From-A (n=25) vs CE-Treatment-Form-A (n=25)	NO: The two CE groups (Control and Treatment) had similar creative abilities.
ID-Control-Form-A (n=30) vs ID-Treatment-Form-A (n=30)	NO: The two ID groups (Control and Treatment) had similar creative abilities.
CE-Control-Form-A (n=25) vs CE-Control-Form-B (n=25)	NO: The two forms had the same degree of difficulty.
CE-Control-From-B (n=25) vs CE-Treatment-Form-B (n=25)	YES: There was a significant difference in the CE creativity scores as a result of exposure to the creativity training module.
CE-Treatment-From-A (n=25) vs CE-Treatment-Form-B (n=25)	YES: There was a significant difference in the CE creativity scores as a result of exposure to the creativity training module.
ID-Control-From-A (n=30) vs ID-Control-Form-B (n=30)	NO: The two forms had the same degree of difficulty.
ID-Control-Form-B (n=30) vs ID-Treatment-Form-B (n=30)	YES: There was a significant difference in the ID creativity scores as a result of exposure to the creativity training module.
ID-Treatment-From-A (n=30) vs ID-Treatment-Form-B (n=30)	YES: There was a significant difference in the ID creativity scores as a result of exposure to the creativity training module.

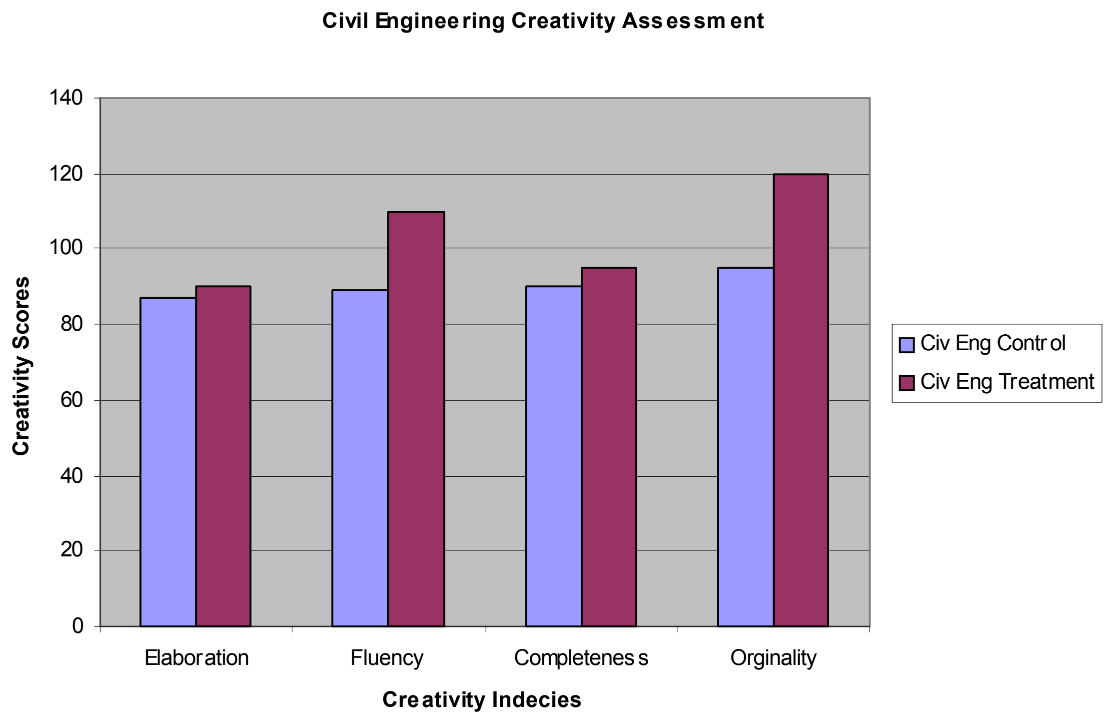

Figure 1. Average of Creativity Indices for Civil Engineering Students.

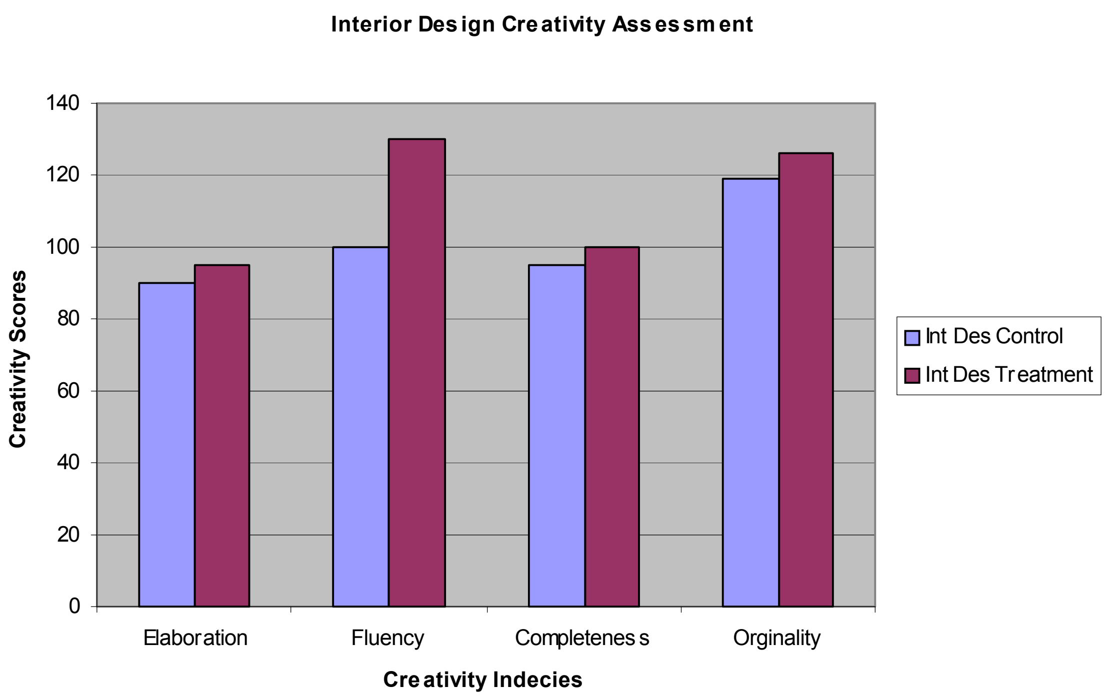

Figure 2. Average of Creativity Indices for Interior Design Students.

VI. Conclusions and Recommendations

Prior to making any conclusions the following points of reference had to be established for both CE and ID classes:

1. There was no significant difference in the degree of difficulty between TTCT-Form-A (pre-test) and TTCT-Form-B (post-test).
2. There was no significant difference in creative abilities of the Control, and Treatment Groups.

The study demonstrated that the creativity training module was effective in influencing the creativity skills of the CE and ID students. However, this influence was not uniform. This non-uniformity across the CE and ID disciplines may be due to different teaching styles and/or student interests. The Civil Engineering students showed improvements in Fluency and Originality, while the Interior Design students improved only in the Fluency category. Obviously, larger data sets are needed to fine-tune these conclusions. More research is needed to include additional creativity indices beyond the four that were discussed in this paper. Future work in this area should continue to further quantify subtle changes in the creative abilities of the students caused by their exposure to the Creativity Training Module (CTM). In this regard, a discrimination analysis (Johnson, 1998; Brieman, 1984; Lachenbruch, 1968) could be helpful.

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