

AC 2010-72: IMPROVING CREATIVITY IN A GRADUATE COURSE

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Abstract

The authors developed a strategy for improving students' creativity in CE 723 – Pavement Systems Management, a graduate course in the Department of Civil and Environmental Engineering. The course taught in Summer 2004 was taken as the control group. This was taught using traditional lecture method. In Spring 2007, this course was taught using the strategy developed in this study. The strategy consisted of creative opportunities provided by the assignments given to the students, creativity on theoretical aspects of a specially designed test and student presentations of the solutions of the assignments. The assignments consisted of a series of modules for minimizing average vehicle delay to clear a busy signalized traffic intersection. Students were encouraged to think outside the box and come up with creative solutions from traffic engineering, geometric design, and signal design considerations. Several examples of creativity were given to the students in the form of handouts. Except this strategy, there was no difference between the control group and the Creative group.

The improvements of all the six performance indices over the control group were determined using t tests. The improvements of all the indices were statistically significant at an alpha value of 0.05. Among the six indices, improvement in student presentations of the solutions to the assignments was ranked the highest. The authors consider this index to be the most important among the 6 indices because it provided the most number of creative avenues for the students. In this category, the control group had scored 52% on the average whereas the Creative group scored 65%. The Creative group showed a 25.0% improvement over the control group.

Introduction

It has long been debated whether creativity can be taught, and if people are born with creativity or acquire it as they learn. This paper is based on the assumption that every student possesses a credible level of creativity. Hence students can be taught to access at least their original levels of creativity, and if the environment is congenial, they may enhance it. The academic world is called upon to improve the standard of teaching¹. The weakness of the traditional lecture becomes clear as we learn how students learn the subjects². Variables such as thinking, reasoning and inherent creative ability from the students' side, and teaching with thought-provoking strategy from the instructor's side, providing the students with options, and creating challenging situations enhance the creativity of the students. The lecture method of teaching must be replaced by a more hands-on, technology based learning atmosphere³. The findings of these references encouraged the authors to conduct research with an objective to improve creativity in a graduate course for enhancement of students' performance.

Literature Review

The improvement of performance of students is the focus of this paper. Kim⁴ found that allowing mistakes increases the students' performance on creativity. Ross and Taher⁵ reported that rewarding creative ideas and products will increase creativity. Shalley⁶ found that encouraging questioning of assumptions also increases creativity. Runco and Albert⁷ suggested that altering people to the obstacles that creative people must face and overcome them will help enhance creativity. Brooks and Jahanian⁸, and Lumsdaine and Lumsdaine⁹ prescribed that encouraging students to define and redefine a problem rather than always doing it for them will increase creativity.

Methodology

The authors developed a strategy for improving students' creativity in CE 723 – Pavement Systems Management, a graduate course in the Department of Civil and Environmental Engineering. The course taught in Summer 2004 was taken as the control group. This was taught using traditional lecture method. In Spring 2007, this course was taught using the strategy developed in this study. The strategy consisted of creative opportunities provided by the assignments given to the students, theoretical aspects of creativity on a specially designed test

and student presentations of the solutions of the assignments. The assignments consisted of a series of modules for minimizing average vehicle delay to clear a busy signalized traffic intersection. Students were encouraged to think outside the box and come up with creative solutions from traffic engineering, geometric design, and signal design considerations. Several examples of creativity were given to the students in the form of handouts. The creative assignments were given only to the control group. The control group did not include the traditional lecture. Except this strategy, there was no difference between the control group and the Creative group.

Creative opportunities provided by the assignments given to the students: Throughout the course creativity was pursued in the form of fourteen assignments. Once every week an assignment was issued. In each assignment students were required to plan, design or optimize a traffic engineering component. The following traffic engineering components were selected during the course; volume adjustment, saturation flow adjustment, capacity analysis, level of service and split of green, amber and red times. Creativity comes from the need. Therefore creativity was generated by creating the necessity for the students in each assignment. The necessity was organized in the form of restrictions and challenges. The restrictions created the challenges to the students and demanded creativity to overcome the challenges. The restrictions were varied from assignment to assignment, and included in the number and or magnitudes of lanes, heavy vehicles, grades, parking slots, left and right turning factors, cost limitations, peak hour factors, and environmental conditions. These restrictions were formulated based on the works of Runco and Albert⁷. The assignments were open-ended. For each assignment a handout was distributed consisting of three to four different methods for finding a solution to the problem posed. Each method deliberately exceeded only one or two restrictions. The strategy provided students with opportunities to overcome creatively the restrictions through their own plans, designs and optimize techniques, as done in the professional world. At the beginning of the course the instructor announced that no two students should have the same solution. The creative opportunities that were employed in the following 3 subsections were similar to those applied in this subsection.

Creativity on the theoretical aspects of specially designed test: The mid-term exam was specially designed to capture creative aspects on various theories of the subject.

Come up with creative solutions on assignments from traffic engineering, geometric design, and signal design: Open-ended problems were given on traffic engineering, geometric design, and signal design. These 3 topics were considered important in the course syllabus.

Student presentations of the solutions of the assignments: At the end of the semester, students were asked to give presentations on their solutions. This strategy helped each student of the class to pick up the benefit of the creative work done by all the students.

As per Kim⁴ on the first assignment no penalties were assigned due to mistakes. Based on Ross and Taher⁵ 25% of the grade was assigned to the strategy employed on creativity. Students had been constantly encouraged questioning of the assumptions as recommended by Shelly⁶.

Results and Discussion

The improvements of all the six performance indices over the control group are shown in Table 1. Table 2 gives the statistical results that were determined using t tests^{10,11}. The improvements of all the indices were statistically significant at an alpha value of 0.05. Among the six indices, improvement in student presentations of the solutions to the assignments was ranked the highest. The authors consider this index to be the most important among the 6 indices because it provided the most number of creative avenues for the students. In this category, the control group had scored 52% on the average whereas the Creative group scored 65%. The Creative group showed a 25.0% improvement over the control group. Students reported that they had to define and redefine the problems while fine tuning the solutions. This was in agreement with the findings of Brooks and Jahanian⁸, and Lumsdaine and Lumsdaine⁹.

Conclusion

Among the six indices, improvement in student presentations of the solutions to the assignments was ranked the highest. Creative opportunities provided by the assignments given to the students was relatively ranked the lowest. The innovative strategy can be applied to other science and engineering courses. The authors plan to extend this strategy to 4 other graduate courses over the next 4 years. The method presented in this study may be used elsewhere in the nation with appropriate modifications in order to engage our students to learn the graduate courses more effectively.

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Table 1. Improvement of the Creative Group over the Control Group

Performance Index	Control Group (%)	Group (%)	Improvement (%)
Creative opportunities provided by the assignments given to the students	68	77	13.2
Creativity on the theoretical aspects of a specially designed test	58	69	19.0
Come up with creative solutions on assignments from traffic engineering	66	79	19.7
Student presentations of the solutions of the assignments	52	65	25.0
Come up with creative solutions on assignments from geometric design	59	68	15.3
Come up with creative solutions on assignments from signal design considerations	58	69	19.0

Table 2. Statistical analysis of Performance Indices

Performance Index	Standard Deviation		t value
	Control Group	Creativity Group	
Creative opportunities provided by the assignments given to the students	9	10	2.0
Theoretical aspects of creativity on a specially designed test	10	11	2.2
Student presentations of the solutions of the assignments	11	9	2.7
Come up with creative solutions on assignments from traffic engineering	8	11	2.9
Come up with creative solutions on assignments from geometric design	7	8	2.5
Come up with creative solutions on assignments from signal design considerations	10	7	2.7

Reviewer Comments

1 _____

2-accept, only after major revisions have been made.

This paper presents a strategy for improving creativity in a graduate course on pavement systems management. The paper assesses a control group using the traditional lectures and a creative group that used creative opportunities. The creative group showed significant improvement over the control group. I feel that the paper is a valuable contribution to the literature, however, the paper did not include the creative opportunities that were employed in the course to improve student creativity. The inclusion of the creative opportunities discussed on page 3 would be a valuable resource for instructors and needs to be included. The following items need to be also addressed before the paper can be accepted:

- The format of the paper is not in accordance to ASEE guidelines (see <http://www.asee.org/conferences/annual/2010/upload/2010-Draft-Paper-Format-Example.pdf>).
- The ASEE policy is to carry out a blind review. In the future the author's institution should not be included.
- The literature review section is appropriate and valuable, however, the authors do not state how their work ties into the literature.
- The methodology section describes the difference between the control group and the creative group. It was not very clear what is the real difference between the two groups. Did the creative group include the traditional lecture? Where assignments given to the control group? If so, what is the difference? Etc.
- The creative opportunities should be included in the paper since they would be a valuable resource for instructors who teach this type of course. Furthermore, they would also provide examples of how instructors could add creative opportunities to other courses.

- The reference section should be titled bibliography.

The creative opportunities that were employed in the course to improve student creativity were included in the paper.

2 _____

[None Provided]

Authors' responses

The creative opportunities that were employed in the course to improve student creativity were included in the Methodology section. The format of the paper was modified in accordance to ASEE guidelines. Author's institution was removed. The authors stated how their work tied into the literature in the Methodology and Results and Discussion sections. The creative assignments were given only to the control group. The control group did not include the traditional lecture. These two sentences were added at the bottom of first paragraph of Methodology section. The reference section was titled bibliography