The Effect of Incorporation of Empowerment Projects on Student Performance in a Civil Engineering Course

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Abstract

In this paper, student empowerment was utilized as a tool in design, discovery, and learning. The primary objective of this study is to provide adequate learning experience for the student within the scope of the syllabus for the course. In this study, a courses repeated over four years (once every year) was considered. Students were directed to undertake engineering designs in specialized areas of transportation engineering and technology. Design topics applicable to these areas reported ranged from Flexible Pavements, Rigid Pavements, Asphalt Paving Technology, Pavement Rehabilitation, to Signalized Traffic Intersections. These topics covered not only conventional transportation systems but also intelligent transportation systems. The students' presentations were peer-graded.

The significance of empowerment in design, discovery, and learning was extensively documented by applying appropriate statistical tests. Assessment, grading formula and results are tabulated. The best papers maintained the standards for publication at appropriate local, regional and or national conferences.

Introduction

The weakness of the traditional lecture is well established by the regular calls from the academic world to improve the standard of teaching (1-3). The lecture method of teaching must be replaced by providing more empowerment to students in various categories of learning such as design, discovery, innovation, and creativity (4,5).

The objective of this paper is to describe the effect of various types of student empowerment projects on student performance in a civil engineering course.

Methodology

A course, CE 342: Transportation Engineering repeated over four years was considered. In the year 2000, the course was taught in the traditional lecture format for nineteen students. The average grade for this student population was sixty nine out of one hundred. In 2001 eleven students, in 2002 eleven students and in 2003 twenty eight students were taught and given empowerment in three categories: design, discovery and learning respectively (one category per year). In each category students were free to work in any one of the five areas: Flexible Pavements, Rigid Pavements, Asphalt Paving Technology, Pavement Rehabilitation and Signalized Traffic Intersections. Students were free to select their own problem or choose from the data bank of the questions provided to them. While using the data bank questions students need not spend time to collect data because the data was supplied to them. An example of the

questions is shown in Table 1. Prior Senior Design Projects, for example reference 6, provided excellent model problems for the students.

Table 1. Student Empowerment in Design

An Open Ended Problem of Designing a Signalized Traffic Intersection

Conduct 5 computer optimization runs using HCS 2000 (latest edition). Submit individual reports. You have empowerment in choosing the following variables on the open ended problem.

1. Signal phasing duration: Red, Green and Yellow timings
2. Design strategy for minimizing the global average vehicle delay of the intersection

Answer the following.

1) What is the global minimum intersection delay?
2) Write a report on the project including a critique on the process, progress and results.

East-West: Green time= 20-40 Sec., Cycle time= 60-110 sec.
North-South: Green time= 30-50 Sec,

For each run report the following:

1. Intersection delay
2. Intersection Level Of Service (LOS)
3. Submit a detailed report (12-25 pages)
4. Write a critique on your results (1-1.5 pages)

In the Design category students were allowed to select a design problem of their choice in one of the five areas. The design problems were reviewed by the instructor for ensuring quality standard of the course. The student empowerment in discovery included an application of a research paper to a real life problem chosen by the student. In this category among other things students were exposed to a large database of research papers. References 7-10 are some examples of the research papers provided to the students.

For the purpose of this study, the category of learning included innovation, creativity, hands on projects and presentation (4,5). To create a congenial atmosphere for learning, students were given several challenges and choices. The challenges were: the students should work with what the laboratory had; the students should not use any ready-made commercial parts; their product should not cost more than $200 (excluding their labor) and all the parts of their model must be environmentally safe and recyclable (4,5). The overall course grading formulas for each course taught in each year are shown in Table 2.

Table 2 Grading Formulas

	Traditional Method (Percent)	The three Empowerment Methods (Percent)
1. Assignments	20	20
2. Attendance and class participation	10	10
3.Examinations (Mid & Final)	70	50
4. Student empowerment project		20
Total	100	100

In order to evaluate the improvements we need to make sure that we are comparing apples to apples only. This was obtained by replacing twenty percent grade of the examinations in the traditional method with the same amount of grade in the empowerment method. Except this there was no difference between the two methods. This was established by the design of the overall course grading formula shown in Table 2. The traditional lecture format and the three empowerment methods have eighty percent of their grade the same requirements. All the courses were taught by the same instructor. The level of difficulty for the eighty percent of the grade was the same in all the courses. In the traditional lecture format twenty percent (ten percent from the mid examination and ten percent from the final examination) of the grade from the examinations was replaced by the respective empowerment method.

Since the t-test is an excellent tool for comparing the means of two groups, this was used to compare the mean of each empower method over traditional lecture method. With three or more groups the t-test is not an effective statistical tool. From the statistical view point, using the t-test for comparing multiple means leads to biased results. In order to find out whether or not all the averages of the set of groups; population, design, discovery and learning are equal F-test was utilized.

Discussion

Table 3 shows the influence of students' empowerment in design in the five areas. The average grade was improved from the base value of sixty nine to eighty eight. With t-score of 2.62, the p-value is 0.015, a score that formed the basis to reject the null hypothesis and conclude that the empowerment in design made a statistically significant difference on the performance of the students in the course. Notice that the p-value achieved should not be greater than 0.05 in order to establish the statistically significance for the 2-tialed t-test.

Table 3. Influence of Students' Empowerment in Design

No. of Students: 11

Lec. For-mat Grade	Teaching with Students' Empowerment							t-Test Score	Statistical Significance @ 0.05 (2-tail)
	Design Areas								
	1	2	3	4	5	Avg	SD		

						Grade			
69	80	96	80	96	88	88	7.1	2.62	Achieved 0.015<0.05

Table 4 shows the influence of students' empowerment in discovery in the five areas. The average grade was improved from the base value of sixth nine to eighty six. With t-score of 2.41, the p-value is 0.025, a score that formed the basis to reject the null hypothesis and conclude that the empowerment in discovery made a statistically significant difference on the performance of the students in the course.

Table 4. Influence of Students' Empowerment in Discovery

No. of Students: 11

Lec. For-mat Grade	Teaching with Students' Empowerment							t-Test Score	Statistical Significance @ 0.05 (2-tail)
	Design Areas								
	1	2	3	4	5	Avg Grade	SD		
69	93	80	77	94	87	86	6.9	2.41	Achieved 0.025<0.05

Table 5 shows the influence of students' empowerment in learning in the five areas. The average grade was improved from the base value of sixty nine to eighty six. With t-score of 2.25, the p-value is 0.035, a score that formed the basis to reject the null hypothesis and conclude that the empowerment in learning made a statistically significant difference on the performance of the students in the course.

Table 5. Influence of Students' Empowerment in Learning

No. of Students: 28

Lec. For-mat Grade	Teaching with Students' Empowerment							t-Test Score	Statistical Significance @ 0.05 (2-tail)
	Design Areas								
	1	2	3	4	5	Avg Grade	SD		
69	82	93	79	96	78	86	7.4	2.25	Achieved 0.035<0.05

The t-test is a useful tool for comparing the means of two groups. On a practical level, using the t-test to compare many means is a cumbersome process in terms of the calculations involved. Therefore, F-test was used to compare the means four groups: Population, Design, Discovery and Learning groups. Table 6 gives the detailed statistical results of ANOVA while the summary results of the test are shown in Table 7. Table 6 and Table 7 demonstrate that the students'

performances in the four groups are different at statistically significant levels. While analyzing the results of Anova test shown in Table 6, one can notice that the high, low and median values are sixty nine with a standard deviation of 0.0. This means that only one data point is used for the population. It is important to note that even though it is only one data point for the purpose of comparing the groups in the Anova test it is actually the average of nineteen students' performance.

Table 6. Detailed statistical results of ANOVA test on the variables of student empowerment.

	Population Average	Design	Discovery	Learning
Mean	69.0	84.0	86.2	85.6
95% confidence interval for Mean	62.45 thru 75.55	77.45 thru 90.55	79.65 thru 92.75	79.05 thru 92.15
Standard Deviation	0.00	8.00	7.60	8.32
Hi	69.0	96.0	94.0	96.0
Low	69.0	76.0	77.0	78.0
Median	69.0	80.0	87.0	82.0
Average Absolute Deviation from Median	0.00	5.60	6.00	6.40

Table 7. Summary statistical results of ANOVA test on the variables of student empowerment.

Source of Variation	Sum of Squares	Degrees of Freedom	Mean Squares	F-value
Between	1005.	3	335.1	7.017
Error	764.0	16	47.75	
total	1769.	19		

The probability of this result, assuming the null hypothesis, is 0.003

Conclusions

The weakness of the traditional lecture is well established by the regular calls from the academic world to improve the standard of teaching. Twenty percent of the overall grade was replaced by various types of student empowerment projects. The empowerment projects were in design, discovery and learning aspects of a civil engineering course. In each category the student performance improved significantly. This was demonstrated by statistically significant increases in the overall course grades.

Recommendations

The following are the recommendations on how these findings would be used in the future for the future offerings of the course. The grade allotted to the empowerment projects will be increased

from twenty to thirty percent. The projects will be expanded to accommodate other tools of learning such as group discussions, presentation and communication skills. There are plans to continue the work presented at least for the next five years.

References

(1) Woods, D. and Crowe, C.M., (1985) Characteristics of engineering students in their first two years, Engineering Education, 74, pp. 289-295.

(2) Boyer, E.L. (1995) Assessing scholarship, ASEE prism, 4, pp 22-26.

(3) National Science Foundation (1992) America's Academic Future (Washington, DC, National Science Foundation).

(4) Robert M Brooks a/k/a: James M. Matthews and S.Jahanian, A Pedagogical Strategy for Gradual Enhancement of Creative Performance of the Students, European Journal of Engineering Education, Volume 24, No. 1. 1999.

(5) S.Jahanian and Robert M. Brooks a/k/a James M Matthews, Multidisciplinary Project-A Tool for Learning the Subject, Journal of American Society of Engineering Education, April 1999, pp 153-162.

(6) Michael Berndt, Ali Alkhatani, Mark Meyers, and Christopher Redeagle, Analysis of a Signalized Intersection at Roosevelt Blvd & Grant Avenue, Senior Design Project, CE-1 Team, 2005

(7) Robert M. Brooks a/k/a: James M. Matthews and Carl Monismith, Direct Tension and Simple Stiffness Tests---Tools for the Fatigue Design of Asphalt Concrete Layers, Transportation Research Record No. 1388, Transportation Research Board, National Research Council, Washington, D.C., 1993.

(8) Robert M. Brooks a/k/a: James M. Matthews, Investigation of Laboratory Fatigue testing Procedures for Asphalt Aggregate Mixtures, Journal of Transportation Engineering, American Society of Civil Engineers, Vol. 119, No. 4, 1993.

(9) Robert M. Brooks a/k/a: James M Matthews, The Effect of Aggregate Gradation on the Creep Response of Asphalt Mixture and Pavement Rutting Estimates, American Society for Testing and Materials, STP 1147, pp 329-347, Philadelphia, 1992.

(10) Robert M. Brooks a/k/a: James M Matthews and B.B. Pandey, Performance of Flexible Pavements, Transportation Research Record No. 1307, Transportation Research Board, National Research Council, Washington, D.C., 1991