Concept Mapping as a Strategy for Higher Performance in Automobile Engineering Exams

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Abstract— worldwide, concept mapping is not a new technique. However, it is yet to be adapted to teaching Automobile Engineering (AE) at University of Maiduguri. In the area of AE, essay tests are the foundations of B. Eng. exams so often required by Examiners. Furthermore, it is generally accepted that practice on related instruments improves students' performance on B. Eng. Exams (E). Thus, the majority of exams given in the AE lecture rooms are essays. The purpose of this study is to determine if incorporating concept mapping to the lecture rooms will create more meaningful knowledge that will improve students' performance on essay tests. AE courses were selected. Concept map training began in the first week of the instruction and continued throughout the semester as considered necessary. Four concept mapping assignments were assigned. The final exam results were compared to results from the same course taught a year before without concept mapping.

Key Words — Automobile Engineering, Concept Mapping, Essay exams, Students' Performance.

1 INTRODUCTION

1.1 Concept Mapping

WORLDWIDE, concept mapping as a tool is not new to education [1]. One of the Concept maps founder "Novak" spent much time with the theme in one of his earliest books, Learning How to Learn in 1984 [2]. Since then, overabundance of research has been accomplished mostly in the sciences and engineering education on all sides of tertiary students. A concept is satisfactorily defined as "a perceived promptness in events or objects, or records of events or objects designated by a label" [3]. In concept mapping nodes are linked together by lines or arrows recognizing with the linking words. The combination of the two concepts and their linking words form a proposition. An example of a proposition may be "engines convert heat energy". The two concepts are engines and heat energy. The connecting or linking word into action is converting. The concepts are as a rule mapped out in a hierarchical order, thus the concept of engines would be placed above the concept of heat energy. The linking arrow, labeled convert, typically only has an arrow head or point when the arrow points in an upward or non-hierarchical direction, as it is assumed that the concepts are arranged starting from top to the bottom of the concept map substructure.

A number of research studies [1]; [4] have confirmed that concept mapping can be introduced to the lecture rooms with relative simplicity. A study [4]; [5] utilized a mere 45 minutes of training for tertiary students while another study [1] used 90 minutes of concept map training for another tertiary students. In the later research study, the time for students to construct a concept map immediately after training, utilizing 20 given concepts, ranged from 16 to 51 minutes, which easily fits into nearly any institution schedule. Correspondingly, the time to grade each map, utilizing one of six methods, ranged from 1.3 to 5.2 minutes, which was likely no more time consuming than lengthy essay quizzes or short essay exams. Communicating the assessment process with the students is the key. They must understand the assessment process in addition for them understanding concept mapping process.

2 PROCEDURE

The prevalent accomplishment of concept mapping in the AE lecture rooms must somehow be justified before all faculty members will embrace the exercise and thus realize the full potential for creating a meaningful knowledge and skill structure within automobile students. Therefore, an easy pilot study was proposed to provide an energizer for further accomplishment and study.

In array to facilitate rapid achievement of the study, existing results or data from previous AE courses were compiled. Useful data included detailed results from several essay tests including the essay final exam, overall grade in the class, and the students current GPA. While several courses were considered, the Automobile Engineering (AE) courses were ultimately chosen for the study due to consistency in instruction, continuity of lecturers, and the willingness of the lecturers to change their teaching style based solely on the

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basis of a proposed study. Thus two AE courses with adequate data from previously taught sections were chosen: AE 203, Introduction to Automobile Engineering and AE 204, Basic Automobile Engineering Service and Testing. These two courses were well developed and taught consistently over time utilizing the same testing instruments from year to year. AE 203 became the first to be studied as it is taught in the spring of each year. Thus AE 204 was the second and final course in the study as it was taught in the fall of each year.

2.1 The Intervention

Preparation of concept maps for the AE 204 spring 2014 section began the second day of classes. The concept mapping exercise was completed in-class. Much of the entire class period, two hours, was devoted to this concept map training exercise. Essentially, students were reviewing material from the AE 203 course taught the previous fall, so, while the two hour session was devoted to concept mapping. The students were concomitantly completing a necessary review. The following week, students were given their first concept mapping assignment. The assignment consisted of a list of twenty concepts relating to automobile restraint systems. Students took the twenty concepts, arrange them hierarchically, add linking words, and thus attempt to create their own version of a concept map. One week was given to complete the assignment. The concept maps were graded on a twenty point scale, given constructive feedback, and returned to the students. The best five concept maps were then displayed and critiqued during class. Using the concept maps as shaping feedback, the remainder of the class time was used to correct inappropriate propositions.

Using the same format, three more concept map coursework were made throughout the semester. The exam (E) themes on which the study was based were: E1 (charging systems), E2 (ignition systems), and E3 (fuel systems). Like the first, each assignment consisted of a list of twenty concepts and required students to arrange the concepts and add linking words. The assignments were worth 30, 35, and 45 points, respectively. Again the top five concept maps for each coursework were presented with critiques of each.

2.2 Data Collection

There were three groups of interest in this portion of the study. The first was a group of thirty students in the AE 204 Spring 2014 class; the second was thirty-two students in the AE 204 Spring 2015 class; and the third was a group of twenty students in the same AE 204 that served as a control group. Data from the 2014 class consisted of scores from two essay tests and one essay final exam. The final course grade and the students' GPA's were also obtained. The same data was collected in the 2015 class utilizing the same instruments, distributed at approximately the same time under similar circumstances. The same lecturer taught both classes and utilized the same materials, with the notable exception of the concept mapping intervention.

Consequently, for the second portion of the study, twenty-eight students in the AE 203 Fall 2014 class was contrasted with the students in the AE 203 Fall 2015 class. As in AE 204, there were three essay exams, two during the semester and one final. The same lecturer utilized the same methods in AE 203 as was used in AE 204. Thus, the same concept map intervention took place with only one notable exception. Students completed six concept map assignments instead of four. These occurred for two reasons: 1) the breakdown of the assignments tends to suggest six mapping assignments as the most practical value, and 2) there was a difference between four concept mapping assignments as opposed to six.

2.3 Analyzing the Data

When the data for the entire study was collected, the data was analyzed using analyses of variance (ANOVA). The scores from each exam E1, E2, and E3 serve as dependent variables. The interventions, 4 maps or 6 maps, or none, served as an independent variable, as was the two courses AE 203 and AE 204. The students GPA was covariates to account for individual and course section differences. An alpha of .05 was used as the impact of making a Type I error which was considered minimal in this circumstance.

Final analysis has been conducted upon the conclusion of the spring 2015 semester. Data compilation is now complete for the AE 204, 2014 and 2015 sections. The final exam scores for each of the two sections were utilized for analysis.

Table 1 of the analysis of variance (ANOVA) summary results reveals that: between and within E1, E2 and E3 groups, the sum of squares are 642.488 and 469.065 with degree of freedoms (df) of 2 and 80, mean squares of 311.74 and 142.14 respectively. The computed F-value is 2100.374 at significance level of .000. In this case, significant differences of the students' performance after attending the AE course in all groups existed. The decision rule for significant alpha value was used to identify where exactly the significant difference exist. According to the rule, if a computed alpha value is greater than the alpha value (0.05), it indicates that the result is not statistically significant. However, if the computed alpha value is less than the alpha value (0.05), it implies statistically significant differences among the results exist.

Based on the decision rule, the result of the analysis in Table 1 indicates that in AE course, the performance of the students in all groups are statistically significantly different. This is because the computed alpha value f-value (2100.374) is greater than the alpha value (.05). Therefore, F (2, 79) = 2.193, at $p > 0.05$(.000) was Rejected. That is, the students' performances are significantly different between the groups. This is because the exact significance level (2.193) provided in the SPSS is greater than the alpha value (0.05). Therefore, since there is a statistically significant difference in students' performance between the groups, there is need for Scheffe's post hoc analyses to determine exactly where the significant differ-

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ence of the students' performance exists [6], this is because the groups are more than two.

Table 1: Post-test ANOVA Analysis of students' Performance in E1, E2 and E3 Groups

Source of variation	Sum of Squares	df	Mean Square	F-value	Sig.
Between Groups	642.488	2	311.74		
Within Groups	469.065	79	142.14	2.193	.000
Total	1111.553	81			

Table 2 shows "Sheffe's Post Hoc" comparison between the students' performance in E1, E2 and E3 groups. From the table, it indicates that students' performance scores of E3 group are statistically significant when compared to E1 group at $p < .05$(.000). Although, the two sets of statistical mean differences are 91.40 and -91.40 respectively, this implies that the differences are not by probability.

In addition, the comparison showed that students' performance in E3 group is statistically significant when compared to E2 group at $p < .05$(.000). Though, the sets of statistical mean differences of the two groups are 90.28 and -90.28. This implies that the differences are also not by chance.

Furthermore, students' performance in E1 group was statistically significant when compared to E2 group, $p > .05$ (.720). Though, the two sets of statistical mean score differences of the two groups are 1.16 and -1.16. This implies that the differences are not by probability.

Based on the Sheffe's Post Hoc pair comparison analysis, the mean post-test score of the students' performance in AE do not exist statistically significant in both E1 and E2 groups, $p > .05$ (1.16 and -1.16 two tailed). Hence the purpose of this study is to determine if incorporating concept mapping to the lecture rooms will create more meaningful knowledge that will improve the students' performance in essay tests.

Table 2: Sheffe's POS HOC Analysis of Comparisons of Students' Performance Scores in E1, E2 and E3 Groups

Treatments (I)	Treatments (J)	Mean Difference (I -J)	Std. Error	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
E3	E1	-91.40*	1.63	.000	-97.29	-90.60
	E2	-90.28*	1.63	.000	-96.11	-89.41
E1	E3	91.40*	1.63	.000	89.59	98.30
	E2	1.16	1.63	.720	-1.67	5.01
E2	E3	90.28*	1.63	.000	88.42	97.10
	E1	-1.16	1.63	.720	-4.02	2.66

3. CONCLUSION

For this research, the preliminary test findings are particularly encouraging. A simple independent test does take the accounts of the lecture room abilities. Using the GPA for conducting an ANOVA with three essay exams, may find the significant differences in some areas and not in others.

Final analysis and appropriate conclusions was available after all data from the fall 2015 semester was collected and analyzed accordingly. As, it should be noted that the students' performance in the concept mapping class appeared to recall and assimilate their knowledge gained through the concept mapping exercise more so than the previous fall class performance. However, the concept mapping class positively showed the students' performance in the AE course compared to the previous fall. This new concept was cited as being too easier to accomplish, and in one student's words, "made me think very comfortable."

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