Work in Progress – Concept Mapping in the Automotive Technology Management Classroom: Does it lead to Higher Scores on Traditional Multiple-Choice Exams?

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Abstract – Concept mapping is not necessarily new. However, concept mapping has yet to be adapted to teaching automotive technology management (ATM) at Indiana State University. In the realm of ATM, multiple-choice tests are the mainstay of certification exams so often required by employers. Further it is generally accepted that practice on similar instruments will improve the scores on certification exams. Thus, the majority of exams given in the ATM classroom are multiple-choice. The purpose of this study is to determine if incorporating concept mapping to the classroom will create more meaningful knowledge that will improve performance on multiple-choice tests. Two courses were selected. Concept map training will begin in the first week of classes and continue throughout the semester as needed. At least four concept mapping assignments will be assigned. The final exam results will be compared to results from the same course taught a year before without concept mapping.

Index Terms – Analyzing the Data, Concept Mapping, Conclusion, Methodology

CONCEPT MAPPING

Concept mapping as a tool is not exactly new to education, as Novak spent much time with the topic in one of his first books, Learning How to Learn in 1984 [2]. Since then, a plethora of research has been accomplished, predominantly in the sciences, encompassing middle, junior, and senior high school students as well as college students. A concept is adequately defined as “a perceived regularity in events or objects, or records of events or objects designated by a label” [3]. In concept mapping, the labels become nodes and are linked together by lines or arrows identified with linking words. The combination of the two concepts and their linking words form a proposition. A simple example of a proposition might be engines convert heat energy. The two concepts are engines and heat energy. The linking or action word is convert. The concepts are mapped (drawn) 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 travels in an upward or non-hierarchical direction, as it is assumed that the concepts are arranged from top to bottom.

Several research studies [1] [4] have proven concept mapping can be introduced to the classroom with relative ease. One study [4] utilized a mere 50 minutes of training for high school students while another study [1] used 90 minutes of concept map training for college students. In the college research, 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 college schedule. Correspondingly the time to grade each map, utilizing one of six methods, ranged from 1.3 to 5.2 minutes, which is likely no more time consuming than lengthy multiple choice quizzes or short essay exams. Communicating the assessment process with the students is the key. They must understand the assessment process in addition to understanding concept mapping.

METHODOLOGY

The widespread implementation of concept mapping in the ATM classroom must somehow be justified before all faculty members will embrace the exercise and thus realize the full potential for creating a meaningful knowledge structure within students. Therefore a simple pilot study was proposed to provide a stimulant for further implementation and study.

In order to facilitate rapid completion of the pilot study, existing data from previous courses were compiled. Useful data included detailed results from several multiple-choice tests including a multiple-choice final exam, overall grade in the class, and the students current GPA. While several courses were considered, two were ultimately chosen for the pilot study due to consistency in instruction, continuity of professors, and the willingness of the professors to change their teaching style based solely on the basis of a proposed study. Thus two courses with adequate data from previously taught sections were chosen: IMT 132, Introduction to Automotive Engines and IMT 233, Basic Automotive Service and Testing. These two courses are well developed and taught consistently over time utilizing the same testing instruments from year to year. IMT 233 became the first to be studied as it
is taught in the spring of each year. Thus IMT 132 will be the second and final course in the pilot study as it is taught in the fall of each year.

I. The Intervention

Training in concept maps for the IMT 233 spring 2005 section began the second day of classes. A concept mapping exercise was completed in-class. Much of the entire class period, two hours, was devoted to this concept map training exercise. Essentially, the students were reviewing material from the IMT 132 course taught the previous fall, so, while the two hour session was devoted to concept mapping, the students were concurrently completing a necessary review. The following week the students were given their first concept mapping assignment. The assignment consisted of a list of twenty concepts relating to automotive restraint systems. Students were to take 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 formative feedback, the remainder of the class time was used to correct inappropriate propositions.

Utilizing the same format, three more concept map assignments were made throughout the semester. The topics were charging systems, ignition systems, and 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 25, 30, and 40 points, respectively. Again the top five concept maps for each assignment were presented with critiques of each.

II. Collecting Data

The two groups of interest in this portion of the study are the twenty-two students in the IMT 233 Fall 2004 class and the eighteen students in the IMT 233 Spring 2005 class. Data from the 2004 class consisted of scores from two multiple-choice tests and one multiple-choice final exam. The final course grade and the students' GPA's were also obtained. The same data was collected in the 2005 class utilizing the same instruments, distributed at approximately the same time under similar circumstances. The same professor taught both classes and utilized the same materials, with the notable exception of the concept mapping intervention.

For the second portion of the study, twenty-eight students in the IMT 132 Fall 2004 class will be contrasted with the students in the IMT 132 Fall 2005 class. As in IMT 233 there are three multiple-choice exams, two during the semester and one final. The same professor will utilize the same methods in IMT 132 as were used in IMT 233. Thus, the same concept map intervention will take place with only one notable exception. Students will complete six concept map assignments instead of four. This will occur for two reasons. One: the breakdown of the assignments tends to suggest six mapping assignments to be of most practical value. Two: there may be a difference between four concept mapping assignments as opposed to six.

III. Analyzing the Data

Once the data for the entire study is collected, the data will be analyzed using multiple analysis of variance with a covariant (MANCOVA). The scores from each exam 1, 2, and 3 will serve as dependent variables. The interventions, 4 maps or 6 maps, or none, will serve as an independent variable, as will the two courses IMT 132 and IMT 233. The students GPA will be the covariate to account for individual and course section differences. An alpha of .10 will be used as the impact of making a Type I error is considered minimal in this circumstance.

Preliminary analysis has been conducted upon the conclusion of the spring 2005 semester. Data compilation is now complete for the IMT 233 2004 and 2005 sections. The final exam scores for each of the two sections were utilized for analysis. An independent samples t-test did not find significant differences $T=(37)1.571$, $p=.13$.

CONCLUSION

For this researcher, the preliminary t-test findings are not particularly discouraging. A simple independent samples t-test does not take into account the classroom abilities. Utilizing the GPA as a covariant and conducting a MANCOVA with three multiple-choice exams may find significant differences in some areas and not in others.

Final analysis and appropriate conclusions will not be available until February 2006, after all data from the fall 2005 semester has been collected and analyzed accordingly. As purely anecdotal, it should be noted that the students in the concept mapping class appeared to recall and assimilate their knowledge gained through the concept mapping exercise more so than the previous class. However, the concept mapping class did not, at first, respond favorably to concept mapping. This new concept was cited as being too difficult, too hard to accomplish, and, in one student’s words, “made me think too much.”

REFERENCES


