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Abstract

Teachers are always looking for innovative ways to help students improve their reading comprehension in subject matter materials. One popular method is the use of graphic organizers such as concept maps. This study examined the use of concept maps to aid reading comprehension of science articles by 10th grade students (n=49) in a Florida high school biology classroom. By comparing scores on reading comprehension tests for two articles, one read without concept mapping and one read while doing a concept map organizing key themes and ideas in the article, significant evidence for the effectiveness of concept mapping was found for one of two groups of participants. These results call for additional investigations into the effects of concept mapping on reading comprehension.

Introduction

During my 15 years of teaching, I have tried to encourage reading to complement textbook information. My interest in improving student reading comprehension of science articles stems from two issues. First, I believe that my own love for reading science literature has increased my desire to provide students with opportunities to sample the fascinating discoveries that are being published every day. I often supplement my lessons with newspaper or magazine articles about current events related to the topics we are studying. However, some of my students have not shared my enthusiasm. Many comment that they feel lost or bored when reading these articles. During discussions that take place after reading in class I found that students had missed the relatedness of concepts that are present in the texts and failed to connect the information to what they had previously learned in my class. It is my passion that my students become life-long learners. If they are reluctant to pick up a periodical or book that challenges and stimulates them intellectually, then they have little chance of keeping up with new information in whatever topic interests them.

Another push to find a technique that would help my students improve their reading comprehension was the implementation in our state of the Florida Comprehensive Assessment Test. This test consists of reading, math and writing portions and will soon involve a science section as well. High schools in Florida are graded partially based on the scores of their 10th graders. Passing the FCAT is also a graduation requirement.

I began to teach my students to use concept maps as a tool that would help them improve their reading comprehension but began to wonder: How do I know if it really works? This research was designed to answer that question.

Literature Review

Concept maps are a type of semantic map. These types of visuals show how ideas and information in a reading passage are related to one another and to previous knowledge the learner has assimilated. This involves assigning a hierarchical relationship of information, beginning with broad categories and branching into related concepts with each then branching into lower levels. All connections are logical and new knowledge can be assimilated into existing knowledge by forming sublevels in a hierarchy (Ausubel, D. (1968). Novak developed concept mapping, using Ausubel's hierarchical model of learning, to specifically include labeling of linking lines to give meaning to the connection and reasons for the levels of organizations between concepts and ideas (Novak, 1990).

Other types of semantic mapping have been found to be effective in aiding comprehension of a reading text (Ausubel, 1968). In one study, in which various types of graphic organizers were used extensively in an entire school district together with computer applications in reading and writing, a dramatic improvement was seen in 11th grade achievement tests (Peresich, Meadows & Sinatra, 1990). This is not surprising. Simply being able to read does not guarantee comprehension. Readers must use the printed words to build on prior knowledge and relate concepts to each other (Antonacci, 1991). Concept maps can help readers to do this. When used in the classroom they can help students relate new concepts to ones they already know and find and understand key concepts in readings (Novak, 1998). Have you ever watched your students quickly lose interest as they read in class? Many times their eyes are staring at the page but you wonder if they actually understand what they read. Mapping is an active reading process that stimulates lazy readers to think more deeply about the ideas in the text because they must figure out relationships between ideas and the hierarchy of their organization (Sinatra & Pizzo, 1992).

Thankfully, in today's classrooms the emphasis of teaching using lecture and rote learning has been greatly reduced. The teacher's role is seen more as coach and facilitator of learning rather than as reciter of knowledge, giving students more control over the process and emphasizing the need to learn how to learn. The process of concept mapping can reduce the need for rote memory and make learning more meaningful (Novak, 1998). For one thing, the actual physical production, drawing, connecting, writing, and the visual aspects, in conjunction with the thought process involved in organizing the map reinforce and deepen comprehension (Wilkes, Cooper & Lewin, 1999). However, students who are used to being given information by their teachers can be slow to warm up to concept mapping. They will find it much more challenging to construct a meaningful relationship on their own rather than having it fed to them by the instructor (Novak, 1998). Therefore it may be assumed that if students are going to buy into the use of concept mapping and incorporate it into their arsenal of successful study habits, they must embrace its benefits.

It may also be said that for teachers to use concept maps effectively and consistently, they must also be able to see evidence of their benefits. This study is designed to test the effectiveness of

concept mapping in improving reading comprehension of a science related text when compared to reading a similar text without using any graphic organizers.

Method

Participants

I used 49 of my tenth grade Honors Biology students as participants in this study. The sample included 22 males and 27 females. Of these, 57% were White non-Hispanic, 29% were Hispanic, 6% were multiracial, 4% were American Indian, 2% were Asian, and 2% were African American. Their percentiles on the reading portion of the Norm Referenced Test on the Florida Comprehensive Achievement Test range from 19 to 98 with a mean score of 69.58.

Materials

I chose the articles used as the reading passages in this study based on evaluations by my school's reading coach, who declared their reading level to be 10th grade or higher. Also considered in choosing these articles was the presence of higher order thinking skills that involved analysis, synthesis and evaluations, based on Bloom's Taxonomy (Bloom, 1956). "The Genome is mapped. Now what?" by Michael Lemonick appeared in Time magazine on July 3, 2000. It was designated as "Article 1". "Genetically Altered Corn" was an article by Jeff Wheelright that appeared in Discover magazine in March 2001. It was designated as "Article 2".

Design and Procedure

I designed a short quiz with a 17-point total to test reading comprehension for Articles 1 & 2. The tests each consisted of seven multiple choice type questions and one essay type question. Again, my school's reading coach examined the tests and articles to check for validity based on test content. Also, to check for validity, to see if the test can appropriately be used to measure reading comprehension, scores on my quizzes were compared to student's scores on the FCAT norm referenced reading test and significant correlations were found. Internal consistency was verified by comparing scores on the multiple-choice section of the quiz to the essay portion. Again, significant correlations were found. A scoring rubric was designed to be used in scoring the essay question to insure reliability of grading that portion of the quiz.

As part of their biology class, the participants were taught concept mapping strategies during the two months prior to this study through instructor modeling, examples and non-examples, peer evaluation, and instructor evaluation strategies. Students were randomly assigned to group A or B. Group A read article 1 on the first day and Group B read article 2. Neither group was instructed to devise a concept map from the reading. Both groups were tested for comprehension using the teacher-made test devised specifically for each article. On the second day Group A read article 2 and Group B read article 1. Both groups were asked to construct a concept map to help them understand related ideas and concepts from their article. After sufficient time was given to read and construct their concept maps, both groups were given the teacher-made test that tested reading comprehension for the article they read. Instructions on both days were read verbatim

from a prewritten script. After testing, students were verbally polled as to whether or not they adhered to directions given. Only data from students who did follow directions was used.

The reading passages were part of a unit of study on genetics. Since current news articles in this field are always used as a graded assignment in some way as part of this unit, all students participated in this assignment. However, only scores from students who signed an agreement to allow their scores to be used as part of this research were considered in the statistical analysis for this study.

The 49 actual participants were drawn from a total of 91 students who began the testing. Some invalidations are described above. Others included those who were absent on one of the testing dates or who became ill during testing.

Results

A paired samples t test was used to compare the difference between reading comprehension Test I, taken without concept mapping the article, and reading comprehension Test II, taken after concept mapping the article. The effects of concept mapping were significant in Group B (t=-5.43, df=28) but not in Group A (t=1.17, df=19). When scores from Group A and B were analyzed together the resulting t value was 1.859 (df=48, p=.069).

Table 1. t Scores for Group A and B Test Totals

	Test I					Test II				
Group	M	SD	n	df		M	SD	n	df	t
A	11.13	2.43	20	19		10.21	2.72	20	19	1.75
B	9.44	2.72	29	28		11.42	2.07	29	28	-5.43*

*p<.05

Table 2. t Scores for Test Totals: Group A and B combined

Test I					Test II				
M	SD	n	df		M	SD	n	df	t
10.03	2.88	49	48		10.83	2.52	49	48	-1.859*

*p=.069

Discussion

This study was meant to test the effectiveness of concept mapping on reading comprehension. The results presented here give slight evidence for its effectiveness, but certainly not strong evidence. As for the obvious differences between the results of Groups A and B there are several possible explanations. It may be that the two articles were not quite similar enough to serve as

controls for each other. The smaller sample size for Group A may not have provided enough data to show significant results. Because of the many invalidations, the total sample size of both groups combined was smaller than originally planned and a larger sample size would be more desirable. Further empirical studies could provide stronger evidence for the benefits of concept mapping. Besides sample size, another limitation of this study was the fairly homogenous sample. A group of participants who were more varied ethnically, and were from a wider range of ability levels and socioeconomic levels would provide data that could be better generalized to this and other similar schools.

Students expressed some important comments in exit interviews conducted after the completion of Test II. Many felt that concept mapping was a difficult task and they would rather read a text passively. This agrees with comments made during interviews from a qualitative study of high school biology students toward their feelings about the use of concept maps in their class. Significant differences in EEG patterns have been found between subjects performing cognitively simple tasks and those performing the more complex task of finding new cross links between ideas on a concept map (Dunn, Novak, Hill, MacQueen & Wagner, 1989). In addition, when I discussed the articles with my students after reading with concept mapping, I could see evidence of a deeper understanding and relating concepts in the articles with concepts learned in our classroom genetics unit. Perhaps a qualitative study looking at verbal discussion would be useful.

This is certainly a topic that deserves further study. Even given its limitations, this study has provided many ideas for ways to modify my teaching practices. It seems that concept mapping can help to stimulate and challenge students to look deeper into their reading. I will continue to have my students construct concept maps from readings. As a result of this study I have begun to analyze these concept maps to look for misconceptions the students may have had about the text so that I can address these issues and clear up misunderstandings. I also use concept maps as pre-writing tools to help students plan essays, lab reports and other short writing assignments. I firmly believe that this and other graphic organizers can be used in many ways in the classroom to encourage higher order thinking.

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