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# THE EFFECT OF THINKING MAPS® INSTRUCTION ON THE ACHIEVEMENT OF FOURTH-GRADE STUDENTS

by

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# THE EFFECTS OF THINKING MAPS® INSTRUCTION ON THE ACHIEVEMENT OF FOURTH-GRADE STUDENTS

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## ABSTRACT

This quasi-experimental study investigated the effects of the Thinking Maps® program, a series of graphic organizers, on the achievement of fourth-grade students as measured by a standardized test. The researcher used a nonequivalent pretest-post test control group design to compare student achievement between fourth-grade students in two elementary schools within a school division. A total of 78 students participated in the study; 41 in two classes in the treatment group and 37 in the two classes in the control group. The treatment group received instruction in the Thinking Maps® program for seven months.

The instrument used to measure the dependent variables (reading, mathematics, and language) was the Stanford Achievement Test (Ninth Edition). Three four-way ANOVAs, with treatment and control, race, gender, and previous achievement level as independent variables were used to compare the students' scaled scores on the post test. Interviews were conducted with the four teachers to collect data on the treatment and control conditions.

The statistical analyses performed on the post test-scaled scores of the fourth-grade students in the study indicated that there was no significant difference between the treatment and control on any of the variables included in this study. While the quantitative analyses could not validate the owner's of Thinking Maps® program claims of improving student achievement as measured by standardized tests, the researcher provides some insight into teachers' and students' reactions to using these graphic organizers as tools for improving classroom instruction.

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# Dedication

This study is dedicated to two special people in my life, my wife and my mother. They taught me the meaning of trust, acceptance, and patience. For their unselfish gifts of love, I am truly grateful.

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## Acknowledgments

The researcher owes a debt of gratitude to a number of people who contributed to the completion of this study. Foremost among those who assisted the author in remaining on task is my wife, Colleen. Her understanding attitude toward the nature of the process and constant encouragement was instrumental in my ability to keep on track. She never complained about the time I spent on the study nor discouraged me in any way. Without her assistance I could not have persevered. This is another reason I love her so deeply.

My study group, formed in the last two years of the quest, was central to my success in completing this degree. Ella, Pat, LyVonnia, and especially Bob were there whenever I needed help in any way. We shared moments of pain and joy and I count them as true friends. Always remember the thrill of taming the “river”.

At first a pleasant voice on the telephone, then a smiling face when we arrived on campus, Paulette Gardner provided that needed assurance that things were going to be alright. If she was involved, you could believe that they would be. She made our transition to campus a pleasure.

All of the professors I encountered at Virginia Tech seemed to want to help us to achieve our goals. They made you feel important in class, remembered your name out of class, and took the time to inquire how all was going. That caring attitude contributed to my desire to work harder to become a part of their circle. I am glad that I did.

I would be remiss if I did not acknowledge the contribution of Sherwin Suddeth of Innovative Sciences, Inc. When I contacted him about conducting the study on Thinking Maps ®, he graciously gave his approval and permission to use the copyrighted materials in the study. I appreciate his willingness to work with me in examining these graphic organizers in more detail.

Finally, I cannot say enough about five people who were there from start to finish, Dr. Niles, Dr. Mutter, Dr. Richards, Dr. Dawson, and Dr. Parks. Dr. Niles and Dr. Mutter allowed me to inconvenience them by agreeing to serve on my committee. Both of them provided



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direction and encouragement throughout the process. Dr. Mutter's edits and advice were invaluable in helping to shape the final document.

Dr. Richards will always be in my mind a mentor. He encouraged me to pursue a brain-based learning topic from the beginning and remained in contact with me regarding brain-learning issues continuously. For his guiding influence I am forever grateful.

Dr. Dawson said yes when I asked her to co-chair with Dr. Richards. I chose her because she has a sense of who she is that is very refreshing. Her warm and unassuming style invited me to feel that I could work with her from the first time we spoke. I have enjoyed our association during the dissertation phase and truly appreciate how hard she worked to make sure I was making progress. Dr. Dawson's positive attitude was always refreshing to hear as we discussed problems on the telephone. Without her believing in me, I could not have made it.

Dr. Park's contribution to the completion of my dissertation is immeasurable while he is a stern taskmaster, he is capable of inspiring an immense amount of respect for the expertise he has in the field of education. Meeting with him on an individual basis provided me the opportunity to learn from someone whose wisdom and knowledge seems limitless. I trusted his advice impeccably and listened carefully to his recommendations. By implementing his suggestions, crafting the dissertation as he instructed, and following his guidelines, I found that what had seemed an insurmountable task became an exercise in allowing the master to show me the way. To Dr. David Parks, I owe a debt of gratitude that I will never be able to repay.

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# CHAPTER IV

# RESULTS

Chapter IV contains the findings. Descriptive statistics comparing the treatment and control schools are reported in one table to allow the reader ease in using the information. The results of the three four-way ANOVAs are reported in tabular form and interpreted.

## Treatment, Gender, Race, and Previous Achievement Effects on Reading, Mathematics, and Language

All statistics were conducted using the Statistical Package for the Social Sciences (Norusis, 1994). There were 78 fourth-grade students in the study, 41 from School A and 37 from School B. Differences in the students' achievement scores on the Stanford Achievement Test were examined for the dependent variables of reading, mathematics, and language. Gender, race, previous achievement and treatment were the independent variables. Mean scaled scores, standard deviations, and maximums and minimums were calculated for the posttest in mathematics, reading, and language for different race, gender, and previous achievement groups.

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Table 9

Reading, Math, and Language Posttest Means and Standard Deviations by Gender, Race, and Previous Achievement in Reading, Math, and Language

School A (Treatment)

| | Reading | | | | | Mathematics | | | | | Language | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Variable | n | M | SD | Min | Max | n | M | SD | Min | Max | n | M | SD | Min | Max |
| Gender | | | | | | | | | | | | | | | |
| Male (M) | 24 | 629.50 | 40.75 | 528 | 732 | 24 | 624.13 | 28.75 | 558 | 671 | 24 | 608.00 | 34.47 | 539 | 676 |
| Female (F) | 17 | 636.18 | 33.51 | 558 | 706 | 17 | 614.88 | 27.76 | 558 | 653 | 17 | 612.00 | 34.99 | 553 | 676 |
| Race | | | | | | | | | | | | | | | |
| Black (B) | 24 | 630.42 | 28.21 | 575 | 706 | 24 | 616.33 | 25.03 | 558 | 653 | 24 | 606.08 | 27.67 | 553 | 676 |
| White (W) | 17 | 634.88 | 48.79 | 528 | 732 | 17 | 625.88 | 32.48 | 558 | 671 | 17 | 614.71 | 47.37 | 539 | 676 |
| Pre/Ach/Read | | | | | | | | | | | | | | | |
| Low(L) | 20 | 611.85 | 29.62 | 528 | 603 | | | | | | | | | | |
| High (H) | 21 | 651.71 | 34.38 | 607 | 732 | | | | | | | | | | |
| Total | 41 | 632.27 | 37.58 | 528 | 732 | | | | | | | | | | |
| Pre/Ach/Math | | | | | | | | | | | | | | | |
| Low | | | | | | 21 | 603.14 | 23.72 | 558 | 587 | | | | | |
| High | | | | | | 20 | 638.30 | 20.87 | 594 | 671 | | | | | |
| Total | | | | | | 41 | 620.29 | 28.37 | 558 | 671 | | | | | |
| Pre/Ach/Lang | | | | | | | | | | | | | | | |
| Low | | | | | | | | | | | 20 | 590.35 | 28.60 | 539 | 580 |
| High | | | | | | | | | | | 21 | 628.05 | 29.13 | 592 | 676 |
| Total | | | | | | | | | | | 41 | 609.66 | 34.31 | 539 | 676 |

(table continues)

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Table 9 (continued)

Reading, Math, and Language Posttest Means and Standard Deviations by Gender, Race, and Previous Achievement in Reading, Math, and Language

School B (Control)

| | Reading | | | | | Mathematics | | | | | Language | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Variable | n | M | SD | Min | Max | n | M | SD | Min | Max | n | M | SD | Min | Max |
| Gender | | | | | | | | | | | | | | | |
| Male (M) | 20 | 626.40 | 35.49 | 558 | 684 | 20 | 609.00 | 34.93 | 540 | 658 | 20 | 603.75 | 31.60 | 556 | 660 |
| Female (F) | 17 | 620.35 | 31.49 | 569 | 668 | 17 | 607.00 | 24.27 | 561 | 644 | 17 | 612.35 | 32.93 | 566 | 676 |
| Race | | | | | | | | | | | | | | | |
| Black (B) | 29 | 619.28 | 30.35 | 558 | 673 | 29 | 606.93 | 33.03 | 540 | 658 | 29 | 606.55 | 30.87 | 556 | 676 |
| White (W) | 8 | 639.38 | 41.05 | 571 | 684 | 8 | 612.25 | 16.54 | 590 | 635 | 8 | 611.88 | 38.05 | 560 | 660 |
| Pre/Ach/Read | | | | | | | | | | | | | | | |
| Low(L) | 18 | 602.22 | 23.83 | 558 | 602 | | | | | | | | | | |
| High (H) | 19 | 643.89 | 28.31 | 607 | 684 | | | | | | | | | | |
| Total | 37 | 623.62 | 33.39 | 558 | 684 | | | | | | | | | | |
| Pre/Ach/Math | | | | | | | | | | | | | | | |
| Low | | | | | | 19 | 588.11 | 25.12 | 540 | 587 | | | | | |
| High | | | | | | 18 | 629.17 | 18.32 | 590 | 658 | | | | | |
| Total | | | | | | 37 | 608.08 | 30.11 | 540 | 658 | | | | | |
| Pre/Ach/Lang | | | | | | | | | | | | | | | |
| Low | | | | | | | | | | | 20 | 588.30 | 23.70 | 556 | 580 |
| High | | | | | | | | | | | 17 | 630.53 | 24.92 | 583 | 676 |
| Total | | | | | | | | | | | 37 | 607.70 | 32.06 | 556 | 676 |

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Table 10

Cell Numbers, Means, and Standard Deviations for Reading, Mathematics and Language used in the Four-Way ANOVAs

School A (Treatment Group)

| | Reading | | | Mathematics | | | Language | | |
|---|---|---|---|---|---|---|---|---|---|
| CELL | n | M | SD | n | M | SD | n | M | SD |
| MBLT | 11 | 616.82 | 20.33 | 8 | 608.50 | 27.52 | 8 | 596.25 | 30.35 |
| MWLT | 2 | 569.50 | 58.69 | 4 | 609.25 | 20.60 | 5 | 584.20 | 34.54 |
| MBHT | 3 | 658.00 | 34.07 | 6 | 632.50 | 21.04 | 6 | 619.00 | 19.72 |
| MWHT | 8 | 651.25 | 43.25 | 6 | 646.50 | 28.14 | 5 | 637.40 | 35.99 |
| FBLT | 5 | 621.80 | 13.01 | 6 | 602.00 | 19.96 | 3 | 583.33 | 16.26 |
| FWLT | 2 | 602.00 | 62.23 | 3 | 583.00 | 23.26 | 4 | 591.50 | 32.54 |
| FBHT | 5 | 652.40 | 31.92 | 4 | 629.25 | 17.71 | 7 | 616.00 | 27.91 |
| FWHT | 5 | 648.00 | 31.46 | 4 | 643.75 | 6.13 | 3 | 658.67 | 14.43 |
| TOTAL | 41 | 632.27 | 37.62 | 41 | 620.29 | 28.37 | 41 | 609.66 | 34.31 |

School B (Control Group)

| | Reading | | | Mathematics | | | Language | | |
|---|---|---|---|---|---|---|---|---|---|
| CELL | n | M | SD | n | M | SD | n | M | SD |
| MBLC | 8 | 598.00 | 24.17 | 7 | 574.71 | 25.62 | 8 | 581.50 | 18.98 |
| MWLC | 2 | 613.50 | 33.23 | 2 | 594.50 | 6.32 | 3 | 592.00 | 37.32 |
| MBHC | 7 | 647.43 | 23.66 | 8 | 637.25 | 21.88 | 7 | 630.43 | 23.94 |
| MWHC | 3 | 661.67 | 29.67 | 3 | 623.33 | 10.21 | 2 | 617.00 | 22.63 |
| FBLC | 7 | 608.29 | 21.71 | 9 | 596.67 | 25.90 | 8 | 595.75 | 24.61 |
| FWLC | 1 | 571.00 | | 1 | 592.00 | | 1 | 572.00 | |
| FBHC | 7 | 626.43 | 29.30 | 5 | 622.00 | 17.28 | 6 | 626.50 | 28.81 |
| FWHC | 2 | 666.00 | 2.83 | 2 | 623.50 | 2.12 | 2 | 656.50 | 4.95 |
| TOTAL | 37 | 623.62 | 33.39 | 37 | 608.08 | 30.11 | 37 | 607.70 | 32.06 |

Note: M=male, F=female, W=white, B=black, T=treatment, and C=control

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## Results of the Analysis of Variance for Reading

There were no significant main effects of gender, race, or treatment on posttest reading scores at the .05 alpha level between School A and School B. Significant main effects were found for previous achievement (see Table 11). Those students who were in the low group on the reading pretest scored lower on the reading posttest than those students in the high group on the reading pretest.

There was one significant interaction effect among gender, race, previous achievement, and treatment on posttest reading scores. Race interacted with previous achievement; however, because the treatment was not part of the interaction, this finding was not explored further.

## Results of the Analysis of Variance for Mathematics

There were no significant main effects of gender, race, or treatment on the posttest mathematics scores at the .05 alpha level between School A and School B. Significant main effects were found for previous achievement (see Table 12). Those students who were in the low group on the mathematics pretest scored lower on the mathematics posttest than those students in the high group on the mathematics pretest. There were no significant interactions among race, gender, previous achievement, or treatment on the posttest mathematics scores.

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Table 11

Analysis of Variance Data for Relationships Between Reading Mean Scores and Gender, Race, Previous Achievement, and Treatment

| Source | df | SS | MS | F | p |
|---|---|---|---|---|---|
| Treatment | 1 | 149.72 | 149.72 | .17 | .68 |
| Gender | 1 | 81.42 | 81.42 | .10 | .76 |
| Race | 1 | 424.64 | 424.64 | .49 | .49 |
| Previous achievement | 1 | 33422.66 | 33422.66 | 38.47 | .00 |
| Treatment x gender | 1 | 1193.02 | 1193.02 | 1.37 | .25 |
| Treatment x race | 1 | 2415.40 | 2415.40 | 2.78 | .10 |
| Gender x race | 1 | 1.16 | 1.16 | .00 | .97 |
| Treatment x gender x race | 1 | 652.41 | 652.41 | .76 | .39 |
| Treatment x pre ach | 1 | 24.94 | 24.94 | .03 | .87 |
| Gender x pre ach | 1 | 188.18 | 188.18 | .22 | .64 |
| Treatment x gender x pre ach | 1 | 760.32 | 760.32 | .88 | .36 |
| Race x pre ach | 1 | 3436.94 | 3436.94 | 3.96 | .05 |
| Treatment x race x pre ach | 1 | 76.50 | 76.50 | .09 | .77 |
| Gender x race x pre ach | 1 | 556.73 | 556.73 | .64 | .43 |
| Treatment x gender x race x pre ach | 1 | 2118.34 | 2118.34 | 2.44 | .12 |
| Error | 62 | 53877.67 | 868.10 | | |
| Total | 78 | 30876461.00 | | | |

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Table 12

Analysis of Variance Data for Relationships Between Math Mean Scores and Gender, Race, Previous Achievement, and Treatment

| Source | df | SS | MS | F | p |
|---|---|---|---|---|---|
| Treatment | 1 | 1783.75 | 1783.75 | 3.57 | .06 |
| Gender | 1 | 255.82 | 255.82 | .51 | .48 |
| Race | 1 | 36.30 | 36.30 | .08 | .79 |
| Previous achievement | 1 | 19148.43 | 19148.43 | 38.32 | .00 |
| Treatment x gender | 1 | 402.38 | 402.38 | .81 | .38 |
| Treatment x race | 1 | 12.33 | 12.33 | .03 | .88 |
| Gender x race | 1 | 173.16 | 173.16 | .35 | .56 |
| Treatment x gender x race | 1 | 22.58 | 22.58 | .05 | .83 |
| Treatment x pre ach | 1 | .24 | .24 | .00 | .10 |
| Gender x pre ach | 1 | 13.19 | 13.19 | .03 | .88 |
| Treatment x gender x pre ach | 1 | 812.87 | 812.87 | 1.63 | .21 |
| Race x pre ach | 1 | 79.90 | 79.90 | .16 | .69 |
| Treatment x race x pre ach | 1 | 1194.29 | 1194.29 | 2.40 | .13 |
| Gender x race x pre ach | 1 | 782.21 | 782.21 | 1.57 | .22 |
| Treatment x gender x race x pre ach | 1 | 83.30 | 83.30 | .17 | .69 |
| Error | 62 | 30977.85 | 499.64 | | |
| Total | 78 | 29521337.00 | | | |

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Results of the Analysis of Variance for Language

There were no significant main effects of gender, race, or treatment on posttest language scores at the .05 alpha level between School A and School B. Significant main effects were found for previous achievement (see Table 12). Those students who were in the low group on the language pretest scored lower on the language posttest than those students in the higher group on the language pretest. There were no significant interactions among race, gender, previous achievement, or treatment on the posttest mathematics scores.

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Table 13

Analysis of Variance Data for Relationships Between Language Mean Scores and Gender, Race, Previous Achievement and Treatment

| Source | df | SS | MS | F | p |
|---|---|---|---|---|---|
| Treatment | 1 | 46.35 | 46.35 | .07 | .80 |
| Gender | 1 | 388.42 | 388.42 | .54 | .47 |
| Race | 1 | 788.29 | 788.29 | 1.10 | .30 |
| Previous achievement | 1 | 28681.28 | 28681.28 | 39.69 | .00 |
| Treatment x gender | 1 | 63.50 | 63.50 | .09 | .77 |
| Treatment x race | 1 | 624.70 | 624.70 | .87 | .36 |
| Gender x race | 1 | 620.06 | 620.06 | .86 | .36 |
| Treatment x gender x race | 1 | 268.40 | 268.40 | .38 | .55 |
| Treatment x pre ach | 1 | 38.64 | 38.64 | .06 | .82 |
| Gender x pre ach | 1 | 915.51 | 915.51 | 1.27 | .27 |
| Treatment x gender x pre ach | 1 | 65.48 | 65.48 | .10 | .77 |
| Race x pre ach | 1 | 1934.01 | 1934.01 | 2.68 | .11 |
| Treatment x race x pre ach | 1 | 265.72 | 265.72 | .37 | .55 |
| Gender x race x pre ach | 1 | 1438.31 | 1438.31 | 1.10 | .16 |
| Treatment x gender x race x pre ach | 1 | 1167.34 | 1167.34 | 1.62 | .21 |
| Error | 62 | 44813.05 | 722.80 | | |
| Total | 78 | 28987289.00 | | | |

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# CHAPTER III

# METHODOLOGY

## Setting

A quasi-experimental study was conducted using data collected from two elementary schools located within a large school division in the southeastern portion of Virginia. This largely suburban school division of 42 individual schools was comprised of approximately 36,000 students in grades K-12. Two elementary schools in the division, designated School A and School B for purposes of this study, have enrollments of 500 and 600 students respectively. School A served grades 3-5 while School B housed grades K-5.

In examining the demographics between the two schools, the researcher selected the two schools as sites for this study because of their comparatively similar student composition. Both School A and School B were located in adjacent school attendance zones in the same section of the city.

According to the school division’s records, the free and reduced-price lunch population of School A was 69%. School B had a free and reduced lunch population of 89%. Census information (1990) indicated that the student populations were very similar in demographic composition. The median household income of a student in School A was $25,455.00, the figure in School B was $16, 061 (1990 U.S. Census). Both schools were in an economically depressed area of the city as reflected by the percent of children living below poverty level. School A had 42% of its childhood population below the poverty level, while School B listed 54% of its students at this level.

## Populations and Samples

Students involved in the study (selected through non-random assignment) were fourth graders in the two schools that were compared in the experiment. Thus the study compared two populations (fourth-grade students in School A and fourth-grade students in School B) and two samples (two fourth-grade classrooms in School A and two fourth-grade classrooms in School B). Comparison of the populations and samples is depicted in Table 2.

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Table 2

Comparison of Populations and Samples

| School | Populations | | Samples | |
|---|---|---|---|---|
| | Teachers | Students | Teachers | Students |
| A | 6 | 165 | 2 | 41 |
| B | 4 | 99 | 2 | 37 |

The researcher purposefully selected the fourth grade as the study population and sample because of three reasons. First, the researcher had access to the fourth grade Stanford Achievement Test results from the September 1998 administration in both schools. This test was eligible for further administration in April of 1999. The sub-tests administered were mathematics, language and reading. Second, this sample selection also allowed for students of like background and age to be considered. Third, previous studies involving graphic organizers have concentrated on students of similar age to determine the effectiveness of similar programs (Boothby & Alverman, 1984; Griffin et al., 1995; Hawk, 1986).

The researcher attempted to limit the variables introduced into the study. The students in each of the participating schools are drawn from the same section of the city and demonstrate similar demographic characteristics. This status was confirmed through a United States Census (1990) document review and consultation with the school division's director of planning. Essentially, the two populations and samples have the same general characteristics in regard to racial, gender, and socioeconomic composition.

## Design of the Study

The researcher employed a nonequivalent control-group design (Gall, Borg, & Gall, 1996) as depicted in Table 3 to test the hypotheses.

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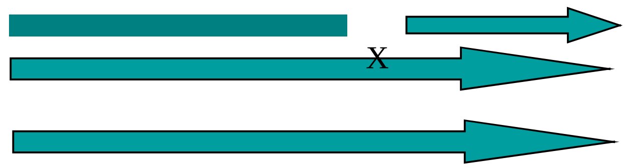
Table 3

Nonequivalent Pretest-Posttest Control Group Design

| School | Pretest | Treatment | Posttest |
|---|---|---|---|
| A | 0 | X | 0 |
| B | 0 | | 0 |



Time (7months)

X = Thinking Maps® 0 = Stanford Achievement Test

Note. The Stanford Achievement Test cannot be administered more than once in a six-month period. Therefore, the experiment needed to encompass a time period of at least six months between pretest and posttest.

The information in Table 3 depicts the design the researcher selected to investigate the research questions. The treatment that students in School A received was classroom instruction in the use of graphic organizers termed Thinking Maps®. Because only two fourth-grade teachers in School A participated in the training required to implement Thinking Maps® in the classroom, the researcher had to limit the number of classrooms to be studied. In School B, two teachers and their classes of fourth graders were selected as the comparison group. The classrooms were selected by matching the two teachers of each school as closely as possible. This procedure is recommended when small samples are to be used and large differences between the treatment and control group on the dependent variable are not expected (Gall, Borg, & Gall, 1996). Matching the teachers involved in the study assisted in decreasing threats to the study's internal validity. The school principals were involved in this process to ensure the best possible match between the two groups of teachers. Attention to teaching styles, years of experience, and overall attitude were factored in to the final decision for selecting the teachers from the two schools. School A implemented the Thinking Maps® program in the school during the 1998-1999 school year. Teachers were formally trained, and instruction in using the program began in early October 1998. School B did not participate in the program, and since the Thinking Maps® program is copyrighted, teachers in School B were prevented from introducing or applying the

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program in the prescribed manner.

To determine how the Thinking Maps® program affects students, the researcher examined three additional independent variables: race, gender, and previous achievement.

The researcher did not find graphic organizer studies that document the effect the use of graphic organizers in the classroom has on the different races. An examination of the school division's free and reduced-price lunch percentage by school revealed that the schools that need to raise standardized test scores the most are often characterized by a high percentage of minority students. The effect of Thinking Maps® on minority students is therefore an important factor to consider. This study was designed to gather data on this aspect of the program's effectiveness.

While a number of studies ( Foxworthy, 1995; Stone, 1983; Tate, 1997) have addressed the effect the use of graphic organizers have on gender, the data provided by the authors of Thinking Maps® does not give any categorizations of how the program may affect males and females. Manning (1998) found little difference in ability between the genders of fourth grade students in science and mathematics. His research indicated that significant differences between the sexes did not begin to surface until the adolescent years. The researcher examined this variable to determine if a specific effect exists between the program and gender.

Studies on graphic organizers have been mixed in reporting their effect on previous achievement. Some maintain that high ability students learn better with the use of strategies such as graphic organizers because they incorporate its structured format with their more organized approach to learning ( Bernard, 1990, 1995; Boothby & Alvermann, 1984; Foxworthy, 1995). Other studies have indicated that students of low ability learn more efficiently with graphic organizers, since the information is presented in a logical, clear format (Alvermann, 1981a; Dickens, 1988; Griffin & Tulbert, 1995; Herbst, 1995; Lehman, 1992). A few researchers have concluded that graphic organizers help both low and high ability students improve achievement (Alvermann, 1981b; LaFleur, 1992; Stone, 1983). Inclusion of this independent variable in the study was designed to assist in gathering data to help interpret which view is more correct.

Thus, the experimental design consists of a 2x2x2x2 factorial design: Previous Achievement (low and high), gender (male and female), race (black and white), and treatment (experimental and control).

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The pretest and posttest that was administered to the students was the Stanford Achievement Test (Ninth Edition). Students in both schools were given the pretest in September of 1998. The posttest was administered to both groups in April of 1999 after the treatment had been given to School A.

## Threats to Internal Validity

In order to control for threats to validity (Gall, Borg, & Gall, 1996), the study was conducted as a blind study. As little information as possible was relayed to the teachers regarding the true purpose of the study. The principals of the schools assisted the researcher with shielding the purpose of the study from the teachers participating in the experiment. Administration of the posttest was conducted in a manner as to not divulge connection to the study. Students involved in the experiment were not informed of any aspect of the study.

As a further means to limit threats to the internal validity of the study, the teachers were not told that the interviews conducted at the conclusion of the study to collect information regarding the classroom use of graphic organizers, was connected to an examination of the Thinking Maps® program. Their principals informed them that the study in which they were participating was being conducted to compare the effects of a fall versus spring administration of the Stanford Achievement Test. The researcher had no contact with the instructional programs employed in the classroom in School A or School B. He did not visit the classrooms or have any direct contact with the study participants. The principals of School A and School B assisted the researcher by monitoring the teachers' classrooms to observe their teaching practices.

Aside from the Thinking Maps® program operating in School A, the two schools' organization for instruction was similar. These similarities in the instructional program include the division-wide reading program (Scott-Foresman), a standardized core-subject curricula, textbooks, and division-wide, policy-driven organizational procedures. The instructional day is similar in both schools with each school providing five and one-half hours of organized classroom activities. Both schools assigned students to classrooms in a heterogenous manner.

## Description of Treatment

The Thinking Maps® program is an established set of graphic organizers that the authors maintain is based on fundamental thinking processes, designed to be integrated within the current

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curriculum. Teachers use these eight graphic organizers to enhance the students' understanding of concepts they present in class through accessing students' visual imagery (Hyerle, 1996a). The maps can be either student or teacher constructed, depending on how the teacher decides to incorporate them into the lesson. Each map is designed to be used with a specific thought process. Hyerle identified eight distinct maps that correspond to the thought processes he outlined in his book, Visual Tools (Hyerle, 1996b). He maintains they comprise a comprehensive model for transferring thinking skills directly to content learning across disciplines and to life long learning (Electronic Resource from Innovative Learning Group, 1997). This results in the outcome of teachers and students utilizing a core set of graphic organizers, or common language, for cognitive development, instruction, and assessment. The function of each of the eight maps is found in Table 4. Diagrams of each of the eight maps are displayed in the Appendix B.

Table 4

Types of Thinking Maps® and Their Function

| Map name | Function |
| --- | --- |
| Circle | To define in context |
| Bubble | To describe the attributes |
| Double-Bubble | To compare and contrast |
| Tree | To classify and categorize |
| Brace | To display part/whole reasoning |
| Flow | To illustrate sequencing |
| Multi-Flow | To examine cause-effect reasoning |
| Bridge | To show analogies |

The Thinking Maps® program can only be implemented in a school after the prescribed initial training for teachers is completed. This training, prior to the use of the program, consists of at least a one-half day session involving the conceptual basis of Thinking Maps®, including a major segment of the session devoted to the brain-based research. The trainers concentrate on the

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brain, especially how it functions, to demonstrate how the Thinking Maps® program correlates with the advances science is making in understanding how the brain is used in the learning process. All of the information presented in the training session is outlined in a carefully formatted manner in the Thinking Maps® training manual.

Participants in School A actively created Thinking Maps® in the training session, learning about their use by constructing them in context. Cooperative learning techniques were used to expedite the learning process, so that all eight maps were introduced in the first training session. Five follow-up sessions, each about an hour in duration, were conducted with the consultants during the school year. The sessions were scheduled throughout the school year at the rate of approximately one every two months. These follow-up workshops generally took place during the teacher's planning bell and were geared to the questions the teachers had about the usage of the maps. The consultants provided additional advice on integrating the maps across the curriculum.

Thinking Maps® was the only instructional strategy or academic initiative School A implemented during the year. All of the other programs follow the format described in the control section.

## Interviews

To accurately describe the treatment and control conditions of the classrooms in School A and School B, the researcher conducted interviews with the teachers participating in the experiment after the treatment and control periods were over. The interview questions were constructed to determine how the treatment and control conditions affected the classroom instruction. The researcher administered the interview questions in the same manner to both groups of teachers. To limit contamination of results, the teachers in School B were interviewed prior to those in School A. A one-on-one interview technique was used to limit distractions and to allow the teacher to focus on each specific question the researcher posed. Each interview was conducted within a forty minute time frame. All of the teachers were asked to respond to the same questions in an identical format. The probes which were used to collect more information were stated in the same way. The researcher attempted to assess the degree of ease each teacher felt in complying with the request to be involved in the interview.

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The information in Table 5 depicts the interview protocol used with the treatment and control teachers.

Table 5
Interview Protocol to Collect Data From Treatment and Control Teachers

| Domain | Interview questions |
|---|---|
| Quantity of use: | 1. Tell me about your instructional program in reading.<br>2. Tell me about a typical lesson.<br>3. Tell me about a typical week in your classroom.<br>4. Tell me about any special activities in your classroom.<br><br>(Ask same questions for math and language)<br><br>Probes (used if teacher mentions visual tools):<br><br>1. What type of visual tools do you use?<br>2. How often are they used?<br>3. How many maps have you used with students? |
| Quality of use: | 1. What types of instructional strategies do you use?<br>2. Describe some of the strategies you use to assist students in understanding the content.<br><br>Probe:<br>1. Describe your experience in using Thinking Maps® in your classroom. |
| Outcomes of use: | How well do you think your students did in reading, math and language this year? Why? |

(table continues)

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Table 5 (continued)

| | |
|---|---|
| Procedure: | How do you structure the use of your instructional strategies?<br><br>Probe:<br>1. Is the visual tool used purposively?<br>2. How does the visual tool relate to the lesson being taught?<br>3. How did you use the Thinking Maps® in your lesson; to introduce new material, reinforce previously taught material, or provide a framework for processing information? |

Probes were formulated to proved the researcher with a tool to explore further avenues of questioning involving graphic organizers. If the teachers mentioned graphic organizers during the interview, the appropriate probes were asked in order to describe how the graphic organizer was used in the classroom in relation to the curriculum. Probing questions that were addressed to the teachers related to the duration of the treatment activity in the classroom, the frequency of treatment usage, and total number of maps introduced to the students. The information reported in Table 6 shows the dichotomy which the researcher found in the use of graphic organizers between the two groups of teachers.

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Table 6

Frequency of Use of Graphic Organizers in the Classrooms of Treatment and Teachers

| Subject | Frequency of Use | | | | |
|---|---|---|---|---|---|
| | Low | | Middle | High | |
| Reading | B1[a] | B2 | | A1 | A2 |
| Mathematics | B1 | B2 | | A1 | A2 |
| Language | B1 | B2 | | A1 | A2 |

[a]B1, B2: Control teachers ;[b]A1, A2: Treatment teachers

School A teachers used some type of graphic organizer, including Thinking Maps® on a regular basis as part of the prescribed program. Teachers in School B did not use graphic organizers in a structured manner. Rarely was any type of graphic organizer used in any subject other than reading, where program associated visual tools were available to be used with the lesson.

When the researcher interviewed the teachers in School A, the use of graphic organizers was the focus of the interview. Each of the treatment teachers mentioned the use of graphic organizers as an instructional priority within the first five minutes of the interview protocol. Teacher A2 explained how she utilized Thinking Maps® daily to help the students “see” the concepts she introduced. Each teacher cited how they used the Thinking Maps® in all three

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subject areas. Teacher A2 was more enthusiastic about the use of Thinking Maps® as she cited how she delighted in finding as many ways to incorporate them into the lessons she wrote as possible. She stated "Thinking Maps® help children see the connections in the material and therefore help them to remember and understand more of the content". She reported that her class was especially adept in using the maps to assist in organizing their thinking during the pre-writing stage of journal or story composition.

While teacher A2 found the Thinking Maps® easy to use in all of the subject areas studied, teacher A1 was more reserved in her assessment of how she employed them in the classroom. She did not use them as frequently as teacher A2, but stated that she found their usage in mathematics to be especially helpful to students. Both teachers used all eight maps during the study period. Teacher A1 stated she used the maps at least once a week or more. Teacher A2 enjoyed using the maps and stated she used them on a daily basis.

When questioned about what factors could cause their students to improve on the achievement test, both teachers concurred that the Thinking Maps® program in their classroom was a significant contributor. Teacher A2 volunteered that Thinking Maps® would account for forty percent of any increase in test scores her students would achieve.

The probing questions developed in the protocol assisted the researcher in learning specific information about the use of the maps in the teachers classroom. The three themes identified in the literature on graphic organizer research emerged during the interviews with the teachers. Those themes, teacher preparation, graphic organizer dynamics, and the instructional context of graphic organizer interventions will be discussed in Chapter Five of the study. (Moore & Readance, 1984).

The information in Table 7 depicts the quantity and quality of graphic organizer usage by the teachers in School A. Both teachers believed that the use of Thinking Maps® by their students was linked to any improvement that the students may have demonstrated on the second administration of the Stanford Achievement Test.

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Table 7

Raw Data Matrix: Quantity and Quality of Use of Visual Tools by Teachers and Students in School A

| | Use of visual tools | |
|---|---|---|
| Teacher | Quantity | Quality |
| A1 | All eight (TM)[a] used<br>Used TM at least once per week or more | TM used as specified in training |
| A2 | All eight TM used<br>Used TM at least once each day | TM used as specified in training |

[a]TM: Thinking Maps®

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## Description of the Control

School B served as the control in the study. The researcher collected information concerning the school's curriculum used in the fourth grade from the school principal. The school division's regular instructional program was in use in this school. In reading, the Scott-Foresman Reading program had been adopted division-wide. This program does include graphic organizers and other visual tools recommended to be used when introducing new material to be taught in context with the prescribed lessons. These organizers are not intended to be used in the same manner as the graphic organizers that accompany the Thinking Maps® program. Most are Venn diagrams, story maps or simple web maps, used to provide an outline for the student to visualize the information presented.

The mathematics curriculum developed by the school division, is manipulative-based, but does not employ graphic organizers as a central focus of instruction. Students transfer skills learned through hands-on activities to performance tasks using paper and pencil. The teachers in the control school reported that they did not use graphic organizers in their mathematics instruction.

The language program is similar to the reading program, but does not have a graphic organizer component attached to the lessons. Teachers concentrate on journal writing, modeling correct sentence construction, grammar lessons, and the writing process.

During the interviews with the teachers from School B, the researcher followed the interview protocol in attempting to assess the instructional climate of the classroom. Neither teacher mentioned graphic organizers or visual tools in describing their instructional program in any of the three subject areas studied. Activities such as group work, play acting, repetitive tasking, and working with manipulatives were cited as the mainstays of the instructional day.

Teacher B2 stated that any improvement demonstrated by her students could be attributed to the amount of repetition she employs. Teacher B1 was less enthusiastic about the improvement capabilities of her students. She could not identify one aspect of the instructional program that may lead to improved test scores. When asked to specify one reason that test scores may be higher on the second administration, she cited the attention given to test taking strategies in her classroom. Neither teacher attributed any perceived improvement in test scores to any

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usage of graphic organizers or visual tools.

The only mention of graphic organizers by either of the control group teachers came after the researcher introduced the probing questions designed to assess graphic organizer or visual tool usage. When asked directly, the teachers responded that they did use the graphic organizers that accompanied the Scott-Foresman reading series that the division had adopted. However, they volunteered that they did not use the available graphic organizers or other visual tools with each lesson. They had the freedom to use the graphic organizers as often or seldom as they chose. Both of the teachers stated that when graphic organizers were used in the classroom, they were selected from a menu provided by the teacher's guide and used to introduce new material. Story maps and Venn diagrams were used most often by the teachers to illustrate the material covered in the lesson. These were used only on the day the reading series specified to introduce new material to the students. They seldom used graphic organizers in math or language.

The information presented in Table 8 shows that the teachers in School B, while having the availability of graphic organizers through the reading program, seldom used them to provide more than a strategy to introduce new material during reading class.

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Table 8

Raw Data Matrix: Quantity and Quality of Use of Visual Tools by Teachers and Students in School B

| | Use of visual tools | |
|---|---|---|
| Teacher | Quantity | Quality |
| B1 | Did not use graphic organizers other than story maps<br><br>Used infrequently to introduce new material | No training in the use of any graphic organizers |
| B2 | Did not use graphic organizers other than story maps and Venn Diagrams (Scott-Foresman)<br><br>Some usage of graphic organizers to introduce new material | No training in the use of any graphic organizers |

Note: Teachers did not mention any type of visual tool or graphic organizer during the interview. Only with the use of probes did the researcher uncover any use of graphic organizers in the classroom.

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## Data Collection

Both schools administered the Stanford Achievement Test (Primary 3/TA) in September of 1998 and a different form of the same test (Primary 3/SA) was given in April 1999 to the two groups of fourth-grade students. These tests served as the pre and post test instruments. The researcher used the scaled scores the students received in the areas of reading, mathematics, and language on the tests to make comparisons. Data to formulate sample comparisons of the two groups was gathered from the established student data base in each school. The researcher collected statistical information regarding race, gender, and previous achievement level (low and high) on all students in the study. The students' scaled scores on the Stanford Achievement Test were used to rank the students into two groups, low and high. Replacement sampling was not used.

Data collected from various sources is represented in two major types of tables. In Table 9 one set of descriptive statistics are depicted. The data in Table 10 shows the cell numbers, means, and Standard Deviations for each of the dependent variables. Tables 11 through 13 were constructed to illustrate the findings from the analysis of variance on each of the dependent variables of reading, mathematics, and language scores.

## Data Analysis

Students in the treatment group and the control group were compared using the Stanford Achievement Test in reading, mathematics and language. The tests were administered in September 1998 and then re-administered in April of 1999 as a posttest. Analysis of the test data generated by the two groups was done with the Statistical Package for the Social Sciences (Norusis, 1994) Three four-way ANOVAs, with treatment, race, gender, and previous achievement level as independent variables and reading, math, and language total scores as dependent variables, were conducted on the data.

In addition, t-tests were conducted on the pretest scores for each school in reading, mathematics, and language. This was done to determine if the pretest means on each dependent variable were different. Since they were not significantly different, an univariate analysis of variance was preformed on each dependent variable. These results are reported in Appendix A.

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# CHAPTER II

# REVIEW OF THE LITERATURE

## Historical Overview

### Learning Models

In order to place the brain-based research in perspective, it is necessary to develop the background and events that have contributed to our current knowledge of how the brain works. Interestingly, John Dewey is quoted in the literature as one of the first to be connected to the brain-based theory of learning. In the 1930s he pointed out that thinking can be done well or badly, and good thinking, like good manners, can be taught. Thinking takes place when beliefs are formed, when decision making occurs, and in solving problems. If good thinking can be taught, it can have far-reaching applications well beyond the classroom (Bucko, 1997). Many of Dewey's ideas, after a period of rejection and decline, have quietly found their way into our schools, contributing to today's educational model. Sylwester (1998) sees a parallel in how the brain-based research may come to prominence in future years after the intense scrutiny that usually surrounds new ideas has abated.

Before the landmark contributions of Dewey and others, the educational model that dominated our efforts to learn something was uncomplicated. If you wished to acquire a new skill or learn a trade the established path was to apprentice yourself to someone who knew more than you and learn from them. This model worked for anyone within the societal boundaries, rich or poor.

The Industrial Revolution made sweeping changes to this traditional path. A new model soon emerged with the notion that you could bring everyone together in a single place and offer a standardized curriculum. This paradigm was transferred from the workplace to schooling institutions in the 1800s and popularized throughout most of the 20$^{th}$ century (Jensen, 1998). This model, referred to as the "factory model," was a combination of influences from the fields of sociology, business, and religion. Emphasizing useful skills like obedience, orderliness, unity, and respect for authority, the model fit the times and enabled our country to prosper and grow into a world power and educational leader (Daggett, 1991).

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We have followed this model with few variations because it served us well. During the 1950s and 1960s the model was altered by the influences of psychologists who developed the behaviorist theory to explain why humans behaved in the manner they observed. Their behaviorist theories lead to an infatuation with observing and measuring student behaviors, modifying those behaviors in students and either rewarding or punishing them (Jensen, 1998). At the time, these ideas seemed to make sense. Today, Kohn (1993) focuses on what he calls the damage to the educational system that the ideas the behaviorists have instilled within the teaching profession have created. Kohn maintains that rewards and punishments are not productive in assisting students in developing the appropriate attitude and mind-set to be receptive to learning. He asserts that students who work for rewards or to avoid punishments will not reach the level of self-awareness needed to instill a genuine desire to learn for the sake of learning.

## Brain Models

The brain itself has been the subject of centuries of study. Primitive models on the workings of the brain date back two-thousand years ago. The Greco-Roman model referred to the brain as a hydraulic system, while during the Renaissance it was likened to a fluid system. The advent of the Industrial Revolution ushered in an appropriate comparison, an enchanted loom. The early 1900s with the accompanying urbanization, saw the brain as a city's switchboard which led directly to the more recent comparison to a computer (Restak,1984).

Early brain theory during this century advocated the need for more right brain learning and educators developed programs to enhance that hemisphere's influence in students' activities (Jensen, 1998). Later, the triune brain theory emerged and gained much popularity, although based on a three-part evolutionary schema that ordered parts of the brain from low to high functioning (MacLean, 1990).

Jensen (1998) believes that history will record that a new paradigm began emerging in the final two decades of the 20$^{th}$ century. Just as the triune brain theory is now outdated, new ideas on how the brain works continue to unfold. Educators today are encouraged to embrace a whole-systems approach to understanding the brain. Jensen (1998) states:

> Technology paved the way for this paradigm shift: it changed the way we think, live, and learn. In the 1970s, 1980s, and 1990s phrases like "super learning" and "accelerated learning" became mainstream as the Information Age blossomed. "Brain scanners" like

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> Magnetic Resonance Imaging (MRI) and Positron Emission Tomography (PET) gave us new ways to understand and see inside the brain. For the first time in history, we could analyze the brain while its owner was still alive. A new breed of "inner science" developed: neuroscience, which is an exciting interdisciplinary approach to questions about the brain. (p. 2)

This is where the tide of history has taken us. But before we can discuss the implications of neuroscience, other important factors and influences which impact our understanding of learning must be explored.

## Frameworks for Learning

Other models and frameworks for learning were concurrent in time with the behaviorists' ideology. One of the fundamental frameworks for teachers to teach thinking skills in the classroom is Bloom's (1956) Taxonomy of Educational Objectives. Educators at all levels use this well-organized structure for the teaching of thinking. Since it was published in 1956, the basis for the work is not grounded in the current brain research. Recent studies have questioned this notable effort and point out that the last few decades of research on cognitive processes have not borne out such clear cut definitive boundaries in the learning process (Hart, 1986).

Others began to align themselves with the thinking skills movement in the 1980s and many traveled around the educational circuit expounding on their own particular brand of methodologies and strategies for increasing performance of students. Among those who rose to the top of the theorist guru status were Perkins (1986), Costa (1985), and Adler (1986).

Perkins (1986) concentrated on improving intelligence through teaching good thinking skills. He defined intelligence as the combination of power (natural ability), tactics (thinking strategy) and content combining to create an enlightened person. His analysis led to the idea that good thinking was not to be found in abundance in the student population, therefore students must be taught these skills in a variety of ways. Perkins described thinking frames or tactics/strategies that enhanced intelligence and prescribed methods for teachers to extract the full potential from students.

The culmination of the thinking strategy approach was a book published by the Association for Supervision and Curriculum Development in 1985 called Developing Minds.

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Edited by Arthur Costa, the book presented useful ways to enhance thinking in such content areas as writing, reading, science, and math. Hundreds of other books, articles, and pamphlets added to the vast array of materials designed to teach thinking. But all of this activity transpired without any clear idea of how the mind actually received, processed, or produced information (Bucko, 1997).

Today, one does not hear the term thinking skills used in educational forums as it was during the apex of the movement. But in the 1980s, a few educators were presenting an alternative view about teaching thinking. One of this group, Adler (1986), supported a content-based instructional approach that involved reading, writing, measuring, testing, and trying to draw conclusions. He claimed that when practical thinking applications were applied to content instruction, meaningful thinking instruction occurred. Adler's ideas helped to lay the groundwork for the modern constructivist theory of educational practice. Constructivism is supported by cognitive research that tells us that making connections within the brain is the key to embedding information in the long-term memory and the ability to apply classroom learning in other contexts (Smilkstein, 1991).

Another immense influence that has assisted in the formation of conceptual frameworks for learning has been the contribution of Howard Gardner (1983) and his work with multiple intelligences (MI). Gardner documented the concept that the brain possesses many forms of intelligence in his landmark work. Most educators are familiar with this theory that describes how more than one type of knowing the world combine to define intelligence. Gardner's research has played a leading role in raising the consciousness of educators toward the importance of learning more about the brain. At present, Gardner has identified at least eight and possibly nine different types of intelligence. In a speech delivered at the annual conference of the Association for Supervision and Curriculum Development in March of 1997 he enumerated the list to include mathematical, musical, kinesthetic, linguistic, spatial, interpersonal, intra personal, naturalist, and perhaps existentialist intelligence.

Gardner based his theory on brain research, previous developmental work with young children, experiments with animals, psychological testing, cross-cultural studies and the works of Dewey, Bruner, Piaget, and Eisner (Reiff, 1997). A number of educators have incorporated

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Gardner's work on multiple intelligences into practices within the classroom (Caine & Caine, 1994). These educators believe that each student possesses at least some potential in each of the eight or nine intelligences. In applying multiple intelligences, teachers can actively involve students in learning experiences, help develop particular intelligences those individual students may lack, and design culturally responsive approaches to reach students who have trouble learning in the school setting. Indeed, brain-compatible learning strategies and teaching to the multiple intelligences may be the most effective way to reach at-risk learners (Reiff, 1997).

Gardner's theory of multiple intelligences is not the first or only model that deals with intelligence or learning styles. Armstrong (1994) relates that there have been theories of intelligence since ancient times, when the mind was considered to reside somewhere in the heart, the liver, or the kidneys. He points out that other authors have identified an array of from one (Spearman's "g") to 150 (Guilford's Structure of the Intellect) types of intelligences. However, Armstrong asserts that Gardner's model is a true cognitive model, whereas seemingly related theories such as the sensory-based Visual-Auditory-Kinesthetic and personality-based Myers-Briggs can not be correlated with the theory of multiple intelligences because they are predicated on a different structural basis.

## Recent Brain Literature

One of the basic realizations about the nature of learning comes from the unofficial name for the times in which we live. The Information Age is an apt phrase for the current epoch in which we strive to understand the world around us. In a recent talk, Dr. Pat Wolfe remarked that the amount of information available is doubling every six months. She predicts that at the current rate, it will soon elevate to double every 72 hours (Boyd, 1998). One area where such an astounding rate of new information is generated at this phenomenal pace is the field of brain research or brain-compatible learning.

Since the early 1980s, there have been a number of books on the bestseller lists that have used findings concerning the brain as fascinating subject matter for millions of readers. Some detail case studies of behavioral abnormalities caused by neurological damage to the brain. Many others are more mainstream and gravitate to the educational applications from the boom in cognitive science (Bucko, 1997). The recent technological revolution has enabled scientists to

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study the cerebral cortex in a manner and depth never before imagined. New discoveries are surfacing every day. Researchers are locating areas of the brain that perform specific functions and speculation is that learning how these areas actually work is not far behind (Sylwester, 1995).

We are learning about the brain at an unprecedented rate. Some researchers claim that anything you learned two years ago is already old information as the field of neuroscience is exploding (Kotulak, 1996). Because we have access to so many new and advanced technologies, scientists studying the brain are on the threshold of many exciting discoveries. Jensen (1998) offers three examples of how medical science has advanced through recent developments in neuroscience. Schizophrenia and Tourette's syndrome can be treated with medication. The causes of Parkinson's and Alzheimer's diseases are close to being revealed. A memory pill, Nimodipine, helps students better recall what they read. Sylwester (1997a) adds that we now know that the biological basis of impulsive and violent classroom behavior has its origins in the amount of the neurotransmitter serotonin present in the brain. All of these discoveries have resulted from our increased ability to study the brain's functions through technological and chemical advances. Before the Decade of the Brain ends, the 1990s may be remembered as the emergence of the chemical learner (Jensen, 1998).

Some researchers have used this new information along with previous research to formulate new theories. Sternberg's Triarchic Brain Theory of Intelligence is one such composite theory that has emerged from the explosion of brain compatible research. His work centers on three elements, creative intelligence, analytic intelligence, and practical intelligence. He believes that successful intelligence is the most effective when it balances all three of its creative, analytical, and practical aspects (Sternberg, 1996).

A new area of research that is gaining much attention is what Goleman (1995) refers to as Emotional Intelligence or EQ. This rapidly expanding field of study is a direct outgrowth of the new ways the brain can be studied and probed for sites that control functioning of our emotions. Studies on the brain have located the area where emotions are harbored, an almond sized structure called the amygdala, which controls the emission of the chemicals that regulate how we react to certain stimuli. Goleman believes that one's emotional intelligence may be more of a measure of success than one's IQ. This is another example of how the recent findings in brain

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research are creating the need to re-examine how we perceive traditional views about how we learn and behave (Gibbs, 1995).

## Unified Brain Theory

Sylwester (1997a) of the University of Oregon says that without an emotional connection, no learning can take place. Reworking the studies of previous researchers he presents evidence that our brains function as a whole system, with all the parts working in unison, to complete the equation we know as intelligence. Sylwester is very interested in formulating a new theory, one that will bring together all aspects of what we know about the brain research and truly revolutionize how we conduct our pedagogy in the public schools.

The emergence of a Unified Brain Theory is still a few years away, and probably not until the next century. But the importance of such a theory will be the driving force that sparks the revolution in brain science analogous to the revolution in the physical sciences sparked by Albert Einstein's relativity theories. To translate the current biological theory into an educational theory will require the vision and foresight of an individual of the caliber of a John Dewey, a Jean Piaget, or a new B.F. Skinner. The theorist who develops this comprehensive theory will join the ranks of history's great scientists (Sylwester, 1997b).

While we await this leader's emergence, others in the field are advocating that educators take steps now to pave the way for cognitive science to explore ways to incorporate this new paradigm in the classroom. They see teachers and administrators conducting action research within their own educational universe to reap the benefits of the explosion of brain-compatible learning (Jensen, 1998). Comparing the development of this new research to current technology, they point out that brain-compatible learning is dynamic. The information changes daily like the influx of information in the technology industry. Waiting for all the knowledge to be assimilated is like waiting to buy the most up-to-date computer. There will always be updates (Jensen, 1998).

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Change in education is notoriously slow. While we do need to exercise caution in jumping on the brain-compatible bandwagon and trying to apply every bit of research that is published before it proves to be sound, we need to be aware of how much evidence supports the power of understanding cognitive psychology. We are on the eve of a learning revolution that has the potential to change our schools for the better (Bucko, 1997).

## Graphic Organizers

### History of Graphic Organizers

One instructional strategy that bridges the gap between the brain-based research and the classroom is the graphic organizer. Graphic organizers are closely aligned with schema theory, one way to explain how the brain thinks (Monroe & Pendergrass, 1997). According to schema theory, when the brain encounters new information it either fits the new information into existing patterns of thinking or modifies its existing structures in order to make sense of the new information. A graphic organizer is a visual representation of how the brain organizes this information (Moore & Readence, 1984).

Many of the sources in the literature agree that the graphic organizer has its roots in Ausubel's (1967) advance organizer (AO). As a cognitive psychologist, Ausubel developed the advance organizer as an attempt to translate his cognitive theory of meaningful reception learning into practice. The advance organizer was an introductory prose passage that the student read prior to reading a longer passage containing new material. It was designed to include content important to the structure of the passage. His rationale for the use of AOs was to assist students in learning new material by providing a framework to link previous knowledge to the material to be learned. Ausubel claimed:

> One of the strategies that can be employed for deliberately enhancing the positive effects of cognitive structure variables generally in meaningful reception learning, and hence for promoting integrative reconciliation, involves the use of appropriately relevant introductory materials or organizers which, in their own right, are maximally clear and stable. These organizers are introduced in advance of the learning material itself, and are also presented at a higher level of abstraction, generality, and inclusiveness; and since the substantive content of a given organizer or series of organizers is selected on the basis of its appropriateness for explaining and integrating the material it precedes, this strategy satisfies the substantive as well as the programming criteria for enhancing the positive transfer value of existing cognitive structure on new meaningful reception learning (p.26)

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Ausubel based a good deal of his theory on four studies he and his colleagues conducted over a period of years. McEneany (1990) conducted a review of the four studies to demonstrate what he considered serious flaws in the research. While some studies which had been conducted in the intervening years had indicated minimal support for Ausubel's theory, McEneany found that a meta-analysis of 135 studies on AOs only had a small facilitative effect. With this many studies, a number of inconsistencies can occur in the definition and construction of advance organizers. McEneany critiqued Ausubel's four original studies and concluded (1) there was no consistent evidence across the four studies in support of the efficacy of advance organizers, (2) the theoretical construct of how the advance organizer operates was not supported and (3) Ausubel himself could not construct an advance organizer that met all of his specifications. More research on Ausubel's theory and advance organizers will be necessary to resolve the questions raised in this review.

Since the AO is in the format of written prose, researchers called attention to the fact that students had difficulty in drawing inferences from so much written material. Robinson (1998) gives an account in his review of how other educators proposed that a graphic display of words showing a hierarchical organization of important concepts would improve students' understanding more than a written paragraph. The "structured overview" (SO) was derived from this idea. It differed from the AO in its ability to illustrate relations among key concepts found in the text. The SO was used to represent the key vocabulary of a learning task.

At this time the debate in the research centered on the placement of the organizer to maximize the students' learning potential. Moore and Readence (1984) conducted an exhaustive meta-analysis in order to review the research on all types of graphic organizers. They addressed the placement of the organizer in their work and explained how the literature found that the structured overview (overview denotes a pre-activity) had experienced little success in the pre-reading position and thus the term was changed to "graphic organizer" or GO. Indeed, they found that GOs enjoyed their greatest success as post reading activities.

Moore and Readence's qualitative review revealed three themes that an earlier quantitative review process had passed over. They identified the role of the teacher in the process and described how classroom teachers who engaged students in GOs tended to feel more

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confident and competent while leading students through the content. Second, they saw GOs changing from a means to link prior learning to new material (Ausubel's original format) to the GO becoming a learning strategy to facilitate comprehension. And third, in studies that reported statistically non-significant findings, students viewed GOs as an isolated learning activity that did not fit the ongoing instructional program. We will revisit these themes in conjunction with the section on Thinking Maps® .

## Graphic Organizer Studies

A number of studies illustrate how research has been conducted in the area of graphic organizers in the last few years. The first study described in this review was a collaborative effort by Wiegmann, Dansereau, McCagg, Rewey and Pitre (1992). Their study focused on how to construct graphic displays to make them more effective for students. Acknowledging that under certain conditions, visual maps can be a more performance-effective alternative than traditional text, they set up an experiment to examine the effects of variations in map configuration on the performance of students with different spatial and verbal abilities. Their premise was that students would perform better using maps that were configured in a manner congruent with the processing priorities of the perception system (e.g., configurations that use gestalt organizational principles of symmetry, proximity, and good continuation).

They chose 37 students from a university as the sample for the study. These students were presented with two map configurations, one which adhered to the gestalt principles of organization and one which was just a web without symmetry. Two memory tests were used in order to assess students' memories of the information presented, one a fill-in-the-blank and the other a multiple-choice measure. In addition, two commercially produced tests used to measure individual differences in spatial and verbal ability were used to correlate the students results with the memory tests on the material. The Group Embedded Figures Test (GEFT) and the Delta Reading Vocabulary (Delta) are two reliable and commonly used tests of spatial and verbal ability.

The means and standard deviations of the findings are depicted in Table 1. Pearson product-moment correlations were computed to examine the relationship between scores on the two individual measures and the scores on the two memory tests. The results of the analyses revealed that scores on the GEFT and the Delta correlated positively and consistently with

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performance of students across both map groups (correlations ranged from r=.24 to r=.32). The alpha levels on all significant effects reported in this study are .05.

Table 1.
Means and Standard Deviations for Percentage Correct on Tests As A Function of Map Group.

| Map Group | Fill-in-the-blank | Multiple-choice |
|---|---|---|
| Gestalt map (n=20) | | |
| M | 73.56 | 80.30 |
| SD | 19.61 | 19.48 |
| Web map (n=17) | | |
| M | 54.12 | 66.27 |
| SD | 18.28 | 17.41 |

In order to determine the reliability of the observations from Table 1, a multi-variate analysis of covariance (MANCOVA) was performed on the memory test scores. Map group (gestalt vs web) was the between group factor. GEFT and Delta scores were used as the covariate. The results of the analysis revealed a significant multi-variate effect for the map group,[ $F(2,32) = 5.48$, $p< .05$]. Uni-variate post hoc tests indicated that students in the gestalt-map group reliably outperformed students in the web-map group on both the fill-in-the-blank, [$F (1,33) = 11.25$, $p < .05$, $w^2 = .23$] and the multiple-choice tests, [$F (1,33) = 5.76$, $p < .05$, $w^2 = .11$]. ($w^2$ is the strength of association measure)

Wiegmann and his colleagues have postulated from these results that a map configured using gestalt organizational principles is congruent with certain processing priorities of the reader's spatial/perceptual systems. They further speculate that the congruency may have facilitated the acquisition of the test information by providing an organizational scaffold and by allowing students to navigate more effectively through the display. Finally, they report that since the effect magnitude revealed that map configuration had a greater impact on students' fill-in-the-blank test performance ($w^2 = .23$) than on their multiple-choice test performance ($w^2 = .11$), the gestalt map may have enhanced retrieval as well as encoding. This result may have profound implications for Thinking Map application. Since Thinking Maps® were designed to access specific brain thought processing functions, such research may collaborate the creators' claims.

A second study that directly relates to the research on Thinking Maps® was conducted by

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Griffin, Malone and Kameenui (1995). Briefly, they sought to answer two questions from the literature on graphic organizers that they believed needed more investigation. The areas of concern involved the teachers' role in the instructional process and program efficacy. The two questions were :

(1) To what degree is explicit instruction necessary for independent generation and use of graphic organizers by students?

(2) Does graphic organizer instruction facilitate comprehension, recall, and transfer of information contained in a expository textbook?

This study tried to answer these questions through a research design that involved using five intact classrooms of fifth-grade students from homogeneously grouped classes (n = 99) divided into five treatment categories. One class served as the control receiving the traditional basal instruction while the others received either explicit instruction with GOs or explicit instruction without GOs or implicit instruction with GOs or implicit instruction without GOs. The rationale for employing this design was to assist the researchers in trying to determine what effects on classroom instruction made a difference in student performance. Video taping of the experiment was conducted to ensure comparability of the teaching presentations given by the investigators.

Additionally, over the course of this ten day long study, the students were administered a series of measures (i.e., immediate and delayed post tests, immediate and delayed recall measures, and a transfer test) to assess their comprehension, retention, and transfer of the social studies content taught to all students. A technique called Johnson's pausal unit analysis procedure was employed to determine the structurally most important units (SMIUs) from the material to be covered. This consisted of having 141 undergraduate students enrolled in education courses to parse the experimental passages into individual units and determine the salient points of the experimental passages.

Statistical analysis consisted of a one-way, between groups multi variate analysis of variance (MANOVA) to evaluate the effects of the treatment conditions on study participants' immediate and delayed comprehension, recall, and transfer of social studies content. The effect of treatment on the combined comprehension, recall, and the transfer variables was statistically

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significant, [$F(20, 372) = 3.366$, $p < .001$].

The bottom line concerning this study is that the researchers concluded from the results that without explicit instruction in a procedure such as graphic organizer instruction, students may not perform any better than expected from traditional methods. While a few problems surfaced in the design of this study, such as the traditional group doing better than expected, the consensus that emerged was that an instructional strategy that is explicitly taught will improve student performance. The design flaw in this study occurred when extra study time was allotted to the control group to compensate for the time used to instruct the other groups in the use of the graphic organizer. This may have accounted for their unexpected performance.

Interestingly, a similar study conducted by Simmons, Griffin, and Kameenui (1988), with sixth-grade subjects studying science earlier had found no significant differences among the groups. In that study too, the traditionally instructed group outperformed the groups receiving graphic organizer instruction.

How Graphic Organizers Affect Race, Gender and Previous Achievement

While many studies involving graphic organizers have been done since Barron and Stone conducted the first study on graphic organizers in 1974, relatively few have contributed information on the three independent variables addressed in this investigation. Griffin and Tulbert (1995) report that over 45 studies have been conducted during this twenty-year span, with many providing contradictory results and recommendations. Reviewing the studies, they point out that there is no constant in graphic organizer research. For example, studies of graphic organizers that are teacher made are not separated from studies of graphic organizers that are student constructed in the meta-analysis research that has attempted to determine facilitative effects. Thus, due to a lack of consistency in study design, the effect sizes obtained in the meta-analysis can be misleading

Griffin and Tulbert propose that graphic organizer research should be conducted in studies where a similar set of visual features and teaching procedures are employed, with the presence of a control group, to increase the likelihood of complementary rather than contradictory study results. Further, they maintain that the independent variables studied should be limited. A study of Thinking Maps® , a graphic organizer program with set parameters, with limited

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independent variables, provides the opportunity to examine graphic organizer usage in the context prescribed by Griffin and Tulbert.

Studies involving graphic organizers that report the affect of race or ethnic composition in using visual tools have not been reported in the literature. The researcher included race as a variable because little is known about the effects of graphic organizer usage in the classroom on student achievement among the races. Thinking Maps® are used by teachers in the classroom with all students. The researcher is interested in discovering how the program affects every student the teacher may encounter in a real classroom, in regard to improving achievement.

In reviewing the literature on achievement and race, the researcher focused on those studies that were central to how graphic organizers impacted upon students. Tate (1997) reviewed mathematics achievement among the races and reported that the achievement gap between whites and Afro-Americans has not narrowed appreciably. He cites as the reason for the discrepancy in mathematics achievement scores between the two groups a deficiency in language proficiency of Afro-Americans. Graphic organizers have been demonstrated to assist students of lower ability in a number of studies (Alvermann, 1981a; Dickens, 1988; Bernard, 1990; Lehman, 1992; Herbst, 1995). Regardless of the students's race, lower ability students are characterized by poor reading achievement. Following this line of reasoning, graphic organizers may have a positive effect in improving lower ability Afro-Americans' achievement scores in reading, mathematics, and language. Any other effects observed from the study with regard to achievement and race will be reported.

No studies reviewed in the literature are able to pronounce that graphic organizers are more suited to males or females as an instructional advantage. Foxworthy (1995) studied 87 fourth and sixth grade students in two elementary schools. Her study design incorporated a pretest and posttest constructed to assess the effects of the modified graphic organizers on the knowledge acquisition of key science concepts and science skills. Gender was included in the independent variables she addressed. Using an ANOVA to compare the interaction between the treatment (graphic organizers) and gender, she found no significant differences for gender.

Stone (1983) analyzed 112 investigations of the graphic advanced organizer, with Glass's meta-analysis technique, and compared the results with predictions from Ausubel's model

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of assimilative learning. While he found that overall, advance organizers were shown to be associated with improved learning and retention of the material to be learned, the resulting effect size attained for gender in this study was not reliable. He stated that the number of effect sizes available were too small for any inference to be made.

Manning's (1998) research on the achievement differences between the genders reveals that at least in one subject area, "as girls and boys progress through the mathematics curriculum, they show little difference in ability, effort or interest until the adolescent years"( p. 168). Hancock, Stock, and Kulhavy (1996) used a 40-item study behavior questionnaire with 793 elementary students to determine how males and females in the fourth and sixth grades differed in study strategies. They found that both fourth-grade boys and girls emphasize overt study activities, but girls are more occupied with text, their thinking appears to be deeper, and their study behavior more deliberate. In sixth-grade, however, the girls are attuned to conscious, planful review for tests, whereas the boys are more concerned with independent study behaviors and deep processing of oral classroom interaction. These researchers believe that these gender differences in study strategies account for gender differences in academic achievement identified in various research studies.

More studies have reported results in regard to the ability of the learner and the impact of graphic organizers than the other two independent variables combined. However, the findings of the studies are not consistent across the research base. Researchers have reported that graphic organizers assist high ability students more than those of lower ability (Boothby & Alvermann, 1984; Bernard, 1990; Foxworthy, 1995; Luiten, Wilbur, & Ackerson, 1980). Luiten, et al., conducted a meta-analysis of 135 studies to determine the facilitative effect of advance organizers on learning and retention. While they assumed that graphic organizers would be most effective with individuals of low ability, the data they collected indicated the opposite held true. In fact, according to their findings, participants defined as high ability have an average effect size of almost twice that of low-ability participants. Although the researchers cautioned against relying on their results because of problems in the consistency of the studies examined in regard to the operational definition of high, middle, and low ability, they recommended that graphic organizers be used in conjunction with high ability students.

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Boothby and Alvermann (1984) studied children in two fourth-grade classrooms (N=38) over a three month period to test the effectiveness of the graphic organizer strategy for facilitating comprehension and retention of information in a social studies text. When the students in the treatment and control groups were given the posttest, students in the graphic organizer group (treatment) recalled significantly more of the total number of idea units (used to score recall) than the students in the control group. The researchers postulated that their findings validated the meta-analysis results of Moore and Readence (1984); graphic organizers benefit high ability students. They reached this conclusion based on the fact that the fourth graders involved in the study were all of average or above average in their verbal ability.

Foxworthy (1995) also indicated in her conclusions regarding her study of fourth and sixth graders that low ability students (in this case students in federally funded programs) scored significantly lower on the adjusted posttest in both grades. The sample involved students in federally funded programs (Title I) whose poor performance in basic reading contributed to their performance. The researcher recommended that visual testing be conducted in the posttest phase of future experiments to reduce this study limitation.

Three studies reviewed by the researcher found that both groups, low and high ability students, benefitted from graphic organizer usage. Alvermann (1981b) tested tenth-grade students on immediate and delayed recall measures and found that all students, regardless of reading level ( a measure of ability) improved in achievement from the use of graphic organizers. Likewise, Lafeur (1992), working with older students at a community college, revealed in a study to improve thinking through using graphic organizers, that no significant differences existed between students of low ability and high ability on the cognitive measure employed to test the hypotheses. However, this study, employing a four group Solomon design, was conducted on a sample total of 29 students.

Stone (1983) using the meta-analysis technique, found that graphic organizers assisted the middle ability group the most. He remarked that Ausubel’s predictions were not confirmed by the results he obtained. Ausubel (1967) had predicted in his model that students having low ability or low prior knowledge of the material to be learned should be helped more by graphic organizers than other students.

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Five studies reviewed by the researcher found that graphic organizers facilitate the learning of low ability students better than high ability students (Alvermann, 1981a; Dickens, 1988; Lehman, 1992; Griffin & Tulbert, 1995; Herbst, 1995). Alvermann studied "lookback behaviors" (p. 326) in sixty-four tenth graders. When a student looked back in the text to find an answer, this action was labeled as lookback behavior. She found that lookback behavior, induced by using a graphic organizer as a road map, differentiated between students who perceived themselves as low-ability comprehenders but not between students who perceived themselves as high-ability comprehenders. This result confirmed her hypothesis that an achievement-treatment interaction would be found between the treatment and the low ability group.

Herbst (1995) investigated 427 ninth graders in her study involving graphic organizer usage in social studies. She concurred with earlier researchers that graphic organizers provided frames for the low ability students to learn material in a clear, logical format. Lehman (1992) adds that graphic organizers allow students to relate information to personal experience, assisting in the need to provide structure and organization for the low ability student.

While both Lehman and Herbst found that students of low ability can benefit from using graphic organizers, Griffin and Tulbert (1995),who conducted a recent review of the literature on graphic organizers, recommend that further examination of the use of graphic organizers with populations of poor readers is needed, given the conflicting results of studies in which reading ability was a variable of interest.

## Themes in Graphic Organizer Research

Three themes have evolved from graphic organizer research; teacher preparation, graphic organizer dynamics, and the instructional context of graphic organizer interventions (Moore & Readence, 1984). These three themes represent the dominant explanations in the literature for how the graphic organizer works.

The first theme Moore and Readence identified, teacher preparation, revealed that teachers who engaged students in graphic organizers reported that they felt more competent and confident with the content while using this instructional strategy. They perceived themselves as better organized, more in control of the learning activity, and more sensitive to the learner's needs in understanding the learning task.

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The second theme, graphic organizer dynamics, focuses on the student learner. Explanations from the research which center on how the student learns through graphic organizer instruction include such strategies as creating an effort at comprehension, processing information at different levels, and rehearsing information.

The third theme relates to the instructional context in which the graphic organizer was used. Moore and Readence recount that in graphic organizer research reporting statistically non-significant findings, students viewed graphic organizers as an isolated learning activity not connected to the material to be learned.

From this overview of the research, it is apparent that some areas of further study in the realm of graphic organizers is needed. But before discussing that topic, a quick introduction to Thinking Maps® is in order.

## Thinking Maps®

### History

The idea of creating a program of Thinking Maps® was first incubated by David Hyerle when he was teaching in an inner-city middle school in Oakland, California in the 1980s. His experiences and frustrations in helping his students make connections to the content resulted in his reliance on strategies such as visual mapping to gain an understanding of how they were processing ideas. When his school piloted a thinking skills program that included diagrams based on several thinking processes, he wondered "What would happen if teachers and students had basic maps for applying different, fundamental thinking processes?" (Hyerle, 1996b, p. 2). He began to formulate the series of graphic organizers that became the basis for Thinking Maps®.

Since that time he has helped to package the program now copyrighted and being sold to schools around the country. As part of the introduction teachers receive during the Thinking Maps® training, extensive brain-based research is made an integral part of the foundation for the program (Implementation and Assessment Guide, 1997). Each map is connected to one thought process, that is, each map is used to depict how the brain thinks about a concept. Figures 2-9 are the eight Thinking Maps® as developed by Hyerle (Hyerle, 1996a).

### Thinking Maps® as Graphic Organizers

From the review of the research on graphic organizers a number of issues of interest

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regarding Thinking Maps® can be developed. Griffin and Tulbert (1995) in their review found only one study that addressed the conditions under which graphic organizers are effective for learning from expository passages. This line of research, examining the conditions where GOs are effective, applies to the problem of implementing Thinking Maps® . What are the optimal conditions to introduce instructional strategies such as Thinking Maps® ? How should the training of teachers be conducted to ensure the best practice? Moore and Readence (1984) call for more studies that concentrate on the length of teacher training and the instructional focus as variables.

Another area where the researchers are questioning the use of graphic organizers is described by Dunston (1992) in her critical review of GOs. She points out that educators no longer question if they work, but want to know how and why they work. Here the path crosses the brain-based research in its quest for understanding of how the brain makes sense of these strategies. Dunston further reports that some studies show that elementary students benefit from GOs more than secondary students in comprehension and free recall. How can these results be explained? Many of the reviewers (Moore & Readence, 1984; Robinson, 1998) found discrepancies in the studies that were difficult to decipher.

The result of these discrepancies have kept the meta-analysis effect size minimal (Glass, 1981). The small differences between effect sizes in the levels of testing in posttest conditions indicate that GOs equally affect short and long-term learning. This implies that GOs may not be particularly effective as a strategy in affecting long-term memory. Robinson and Schraw (1994) found there does seem to be a paradox in using graphic organizers to embed information in the long-term memory. They observed that the advantages of a GO disappear when testing is delayed. Speculation is that because the student can communicate information so effectively that he does not have to “untangle” (p. 400) the necessary information, it is never encoded in the long-term memory process. Graphic organizers were intended to organize information for understanding. Should they be viewed through so broad a spectrum as to demand that they improve student performance?

To conclude, the final area for investigative research fits like a glove with the study of Thinking Maps®. Robinson (1998) in his review quotes Tukey who presents an incredible

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challenge for researchers to construct GOs in a manner that takes full advantage of the power of visual argument. Visual argument involves transmitting ideas through a spatial arrangement of words rather than through written language. By seeing ideas, students are relieved of the burden of untangling complex relations from the linear structure of text. We would know when we have accomplished this because it would be impossible for students to view them without discovering knowledge of concept relations. The discovery of this knowledge should make an immediate and powerful impact on the students.

## Summary of the Literature Review

Brain-based research has emerged as a new frontier in education. Medical science is unlocking the secrets of how the brain functions. Educators are exploring this new information and searching for innovative ways to implement the findings within the classroom. One instructional strategy that is linked to the revelations about how the brain learns is the graphic organizer. Studies on the various types of graphic organizers have been conducted and reported in the literature for thirty years, beginning with Ausubel. While numerous studies have documented that graphic organizers can improve students' abilities in a variety of areas from comprehending vocabulary to remembering text passages, and meta-analyses have reported facilitative effects for graphic organizer use, few studies have focused on how they improve achievement.

This study examined the Thinking Maps® program, a series of graphic organizers that the authors claim will increase student achievement. Administrators, charged with finding ways to increase student achievement in light of the standards movement, need programs that will impact positively on student performance. Thinking Maps® are promoted as a toolkit for students to improve the basics of reading, writing, and mathematics as well as for problem-solving and the development of higher-order thinking abilities (Hyerle, 1996a). This study will add information to the research knowledge base on the use of graphic organizers.

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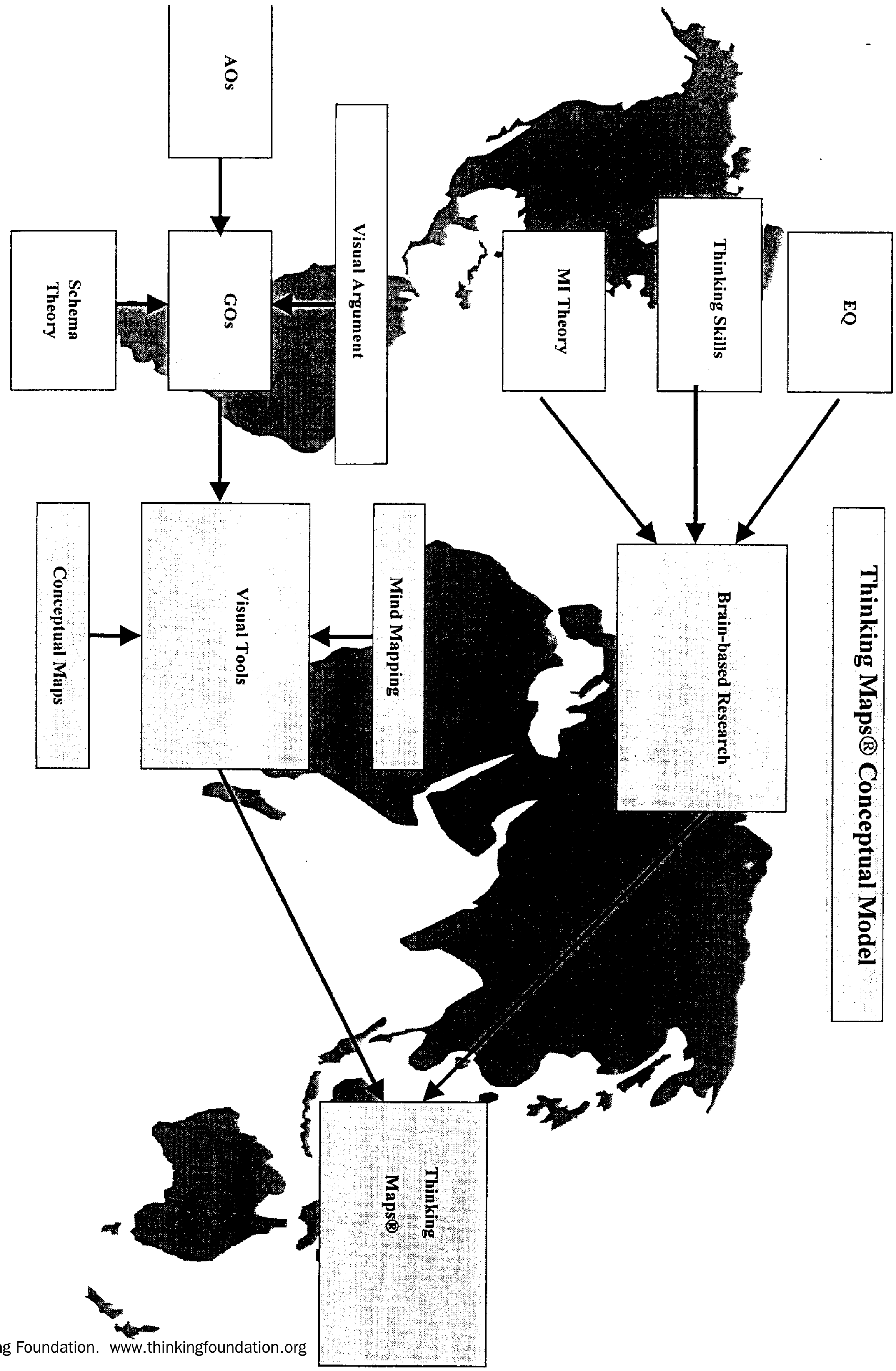

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# CHAPTER V

# CONCLUSION, DISCUSSION, AND RECOMMENDATIONS FOR PRACTICE AND FURTHER RESEARCH

## Conclusion

The primary question raised in this study centered on the use of Thinking Maps® in the classroom to increase student achievement as measured by standardized tests. Given the data results from this study, using these students and these schools, no significant differences were found between the treatment group School A and the control group School B in regard to reading, mathematics, and language achievement. A significant interaction between race and previous achievement was found for the posttest reading scores. This result had no bearing on this study, and so was not explored further. There may be implications for further research related to this finding.

## Discussion

A number of factors could have caused the results found in this study. Foremost among those factors was the size of the cells used to compute the data. Ensuring that only teachers in the treatment school who had been trained in the Thinking Maps® strategy were involved in the study limited the size of the sample in School A to two teachers and their classes. Given this number, the study group in School B had to be composed of two teachers and their classes. To measure increases in achievement, students in the study had to have been administered both the fall and the spring Stanford Achievement Test. Only 41 students from School A and 37 students from School B met these criteria. The 2x2x2x2 factorial design, spread over 78 students in the sample, created small cell sizes (see Table 10). This limitation of the design of the study may have contributed to the lack of significant findings in the investigation.

Another factor that may have played a part in reducing the probability of finding significant results between the study samples is the fact that the Thinking Maps® program is so new in the treatment school. Some researchers (Banerji & Malone, 1993) maintain that any new program should not be evaluated during the first year of implementation. The program needs time to build the power needed to affect such a strong variable as student achievement. Seven months of implementation does not appear to be a sufficient amount of time for this program to

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demonstrate increased student performance on standardized measure such as the Stanford Achievement Test. The authors of the Thinking Maps® program explain that a common visual language has to develop within the school before the full potential of the maps can be reached. When the Thinking Maps® program is used in all the school's classrooms and becomes infused into all parts of the operation of the school, the authors believe the program can enhance student performance to a measureable degree. This infusion process is the critical element that enables the teachers to empower the students to gain the most benefit from the instructional strategy. The authors of Thinking Maps® acknowledge it may take more than a school year for this common visual language to develop within a school.

An additional factor that must be considered in interpreting the results of this study is the use of one form of measurement to derive the scores used to make the comparisons between the two schools. Although the authors of Thinking Maps® maintain that using this program will increase student achievement as measured by standardized tests, it may not be wise to base a final evaluation of the worth of the program upon one form of measurement such as the Stanford Achievement Test. Other means of evaluation should be employed in addition to the Stanford Achievement Test to determine if the program has merit. Criterion referenced tests, such as the Standards of Learning tests developed by the Virginia Department of Education, could be used to measure the achievement of students. Students' daily work and teacher made tests could be examined to provide more insight into how the program affects student achievement.

This study was conducted as a blind study to the teachers and students to ensure that the researcher did not contaminate the results. At no time during the course of the study did the researcher enter the classrooms or reveal the intent of the study to the participants. This design inherently does not correct for any variables that may have been introduced without the knowledge of the researcher. During seven months of public school many intervening variables could come into play in the classrooms chosen to participate in the study. While interviews with the teachers provided an opportunity to examine the curriculum and the instructional program, and conversations with the school principals indicated that nothing out of the ordinary occurred within the classrooms during the study period, the researcher acknowledges that unknown variables could have contributed to the results observed. No speculation is ventured as to the

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degree or frequency of variables that which may have altered the outcome.

## Recommendations for Practice

The researcher was impressed by the teachers' enthusiasm for the student use of the maps in the treatment schools. The interviews in School A quickly focused on how the students enjoyed using the maps in the classroom and displaying things they had learned in map format on the bulletin boards in the hallways outside of their rooms. The principal in the treatment school contributed to the positive climate for Thinking Maps® by encouraging their use in all facets of the school's curricula. Thinking Maps® appeared in the parent newsletter, in hallways, in the cafeteria, and the gymnasium. Public address announcements were made periodically to all students regarding how to use Thinking Maps® . A school-wide emphasis was placed on using these instructional tools.

The researcher can verify that the students in School A learned the proper usage of at least one Thinking Map® during the school year. After the study was completed, the researcher visited a third grade classroom to deliver a presentation. As part of the instruction, the researcher asked the students to design a way to compare two different things. Immediately the students suggested using the double-bubble map as a means of making the comparisons. Employing this map structure, the researcher was able to engage the class in a meaningful discussion.

Some benefit must be derived from the students' ability to assess so quickly what type of map structure would enable them to make the proper comparisons. The reaction of the researcher to the students' suggestion during the presentation mirrors that of the teachers participating in the study. The teachers found that the students liked working with the maps because they better understood the concepts required. The school principal described how teachers reported to her that the students were using the maps prior to writing activities to organize their thoughts. The papers that the students wrote attested to how the maps could be used to improve student performance. In Appendix C there are some examples of actual student-produced Thinking Maps® .

Evidence of the three themes of graphic organizer research cited by Moore and Readance (1984) was noted during the interviews with the teachers in School A. Teacher A2 described how she felt more confident that her students were learning the material by using Thinking Maps® .

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Their perceived improved competence led her to feel that she was a better teacher because she could communicate the content to her students more effectively. This aspect of teacher efficacy was directly attributed to her use of the program in the instructional process.

Both of the teachers in School A reported that the students learned the material presented with Thinking Maps® more readily than with the conventional strategies they had employed before in their teaching. This evaluation of how Thinking Maps® work agrees with the second theme Moore and Readance (1984) found in their meta-analysis: Graphic organizers facilitate comprehension.

The third theme from the literature, that graphic organizers were viewed by students as an isolated activity not connected to what they were required to learn, was addressed by the teachers from School A as well. Although the program was new in the classroom, the teachers were surprised and encouraged by how easily the students adopted the Thinking Maps® organizers as tools to frame their understanding of the content. The researcher's experience with the third graders in School A demonstrates how the students were able to apply their knowledge of their use in a new context.

## Recommendations for Further Research

Design changes that would most logically improve the study would incorporate additional numbers of teachers and students. As pointed out in the limitations of the study, few teachers and students were available for inclusion in the investigation. Expanding the sample groups would limit the threats to the internal validity of the improved study.

This study was conducted as a blind study. The concept of a blind study fit the needs of the quasi-experimental nature of this investigation. The design of the study was basically quantitative, geared to collect specific data and analyze results. Very little qualitative data was collected. To gain a better understanding of how such a graphic organizer program as Thinking Maps® works, a qualitative study allowing the researcher to investigate the workings of the Thinking Maps® lessons should be employed. Providing information on how the program is intended to work with students would assist in explaining the results of this study. A study that analyzes the power of the instructional strategy is needed to determine when the program can be expected to make a viable difference in student achievement scores on standardized tests like the

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Stanford Achievement Test.

A case study format could be used to describe how the program affects the individual student. This type of study would enable the researcher to engage in a long-term investigation of the program and its impact on the classroom. The authors of Thinking Maps® believe that time is needed for the teacher and the students to become familiar with the use of the maps before the full potential of the program can be realized.

More time would help to build a data base of information about the program that the division's research department could assess to determine if the program was achieving the results desired. Collecting data on the numbers of teachers using the program, how many of the eight maps were used within the classroom, the frequency of map usage, and the quality of their usage would enable the division to make a better decision regarding expanding the program to other elementary schools. Examining such variable as how and when the students construct the maps, especially in situation where direct instruction in using the maps was not given, would be helpful in assessing their value. More investigation into how the students transfer their knowledge of map usage would be helpful in learning about how the maps function.

One area where this student transfer of knowledge concerning map usage occurred is connected to student writing. One of the teachers at School A reported that the students, without being instructed to do so, used the maps to organize their thinking prior to attempting to writing journal entries and essays required in class. The students selected the appropriate map to assist them in making sure they included the ideas they wanted to express in their writing. This action represents an acquired behavior that the teacher encouraged as a positive step to organizing their thinking; this is a desired outcome of the Thinking Maps® program. Since this aspect of Thinking Maps® usage is a valued outcome, it should be investigated in a future study.

As with most of the programs in schools designed to increase student achievement, it is difficult to construct a short-term experimental study that presents conclusive proof of improved achievement by finding significance between two groups of students. The research on graphic organizers is illustrative of how variant the findings can be. This study was designed to examine some of the independent variables that were reported as having mixed results in the literature. The findings of this study support those studies (Griffin, Malone, & Kameenui, 1995; Simmons,

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Griffin, & Kameenui, 1998) that did not find that student performance was enhanced by the use of graphic organizers. Both of the studies cited above were also short-term studies (ten days and 17 days).

## Researcher's Recommendations

Based on the cost of approximately $6000.00 per school to implement the program, is the program worth the investment? The answer is yes. The researcher believes that this program holds promise for three reasons. First, the opportunity to develop the common visual language that the authors of the Thinking Maps® program describe has the potential to transform the school curricula. This transformation will not be fully realized until all the teachers in the school become familiar with and use the program in their classrooms. Teachers engaged in sharing ideas on how to use the maps helps to forge better communication within the school. Increased positive communication leads to a more positive instructional climate for the entire school.

Second, the program is focused on teaching students how to organize their thinking. This critical skill is needed at all grade levels across the curriculum. The Thinking Maps® program provides students with a readily understandable visual tool that they can use for improving, applying and transferring their thinking directly to content knowledge. In this same school division, teachers at the high school are reporting that students taking advanced placement tests are using the maps prior to writing their essay exams. The students use the maps to organize the content of the questions so they can respond in a better organized format. These teachers attribute improved scores on the tests to student use of Thinking Maps®.

Third, Thinking Maps® and other graphic organizers appeal to the visual learner. Students in classrooms today, due to the increased opportunity of visual stimulus in their environment, respond to visual tools. Some researchers estimate that forty percent of the students are visual learners (Dunn, K. & Dunn, R, 1992). Many reading programs, like Scott-Foresman, incorporate graphic organizers and visual tools into their curricula to take advantage of the power of visual stimuli.

While this study did not find statistical significance in the quantitative analysis of the findings, the researcher believes that there is good evidence from the limited qualitative information gathered to continue to study the Thinking Maps® program before dismissing its

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value as another educational fad or over-hyped instructional tool. Only more investigation expanding the time frame of the study period and focusing on how the program works with students will enable educators to make a fair evaluation of the Thinking Maps® program.

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# CHAPTER I

# INTRODUCTION

Innovative programs are constantly being implemented in the schools with the purpose of improving a variety of factors that affect how students learn. Some of these programs propose to address the affective domain while others focus on the cognitive aspects of child development. Many of these programs claim high success rates through their connections to the emerging research from such prolific areas as brain-based and learning styles instruction (Bruer, 1997 & Gatewood, 1995).

## Purpose and Significance of the Study

One such program, Thinking Maps®, uses graphic organizers to promote a common language for students to improve their organizational skills, thus improving their thinking skills and their academic performance. The creators of the Thinking Maps® program purport that schools employing this instructional strategy can increase their students' standardized test scores (Hyerle, 1996b). Thinking Maps® are presented as grounded in the brain-based research currently being conducted to link how the brain learns with improved classroom practice. This study focused on the effects that Thinking Maps® have on student achievement, specifically mathematics, reading, and language achievement at the elementary level. The question the researcher posed was "How does participation in Thinking Maps® affect the mathematics, reading, and language achievement of fourth-grade students?"

Thinking Maps® can be an expensive proposition for school divisions and should be carefully examined before a school division commits to full implementation. For each school in a division, the average cost is $6,000.00 for the prescribed training, materials, and follow-up consultations. In larger school divisions, consisting of many schools, this can become a costly initiative. This investigation served as a pilot study for a large school division in Virginia considering the implementation of the program division-wide at the elementary level. The results of the study will be used to assist the school division in determining if it should continue to expend the amounts of money and effort required to place the Thinking Maps® program in each of its twenty-eight schools.

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A research-based investigation of Thinking Maps® will add to the knowledge base pertaining to how graphic organizers can assist in improving student achievement. Graphic organizer research has been reviewed in the literature since the forerunner of the graphic organizer, the advance organizer was developed in the late 1960s (Ausubel, 1967). Studies on the effectiveness of graphic organizers in increasing student learning at the elementary level have shown mixed results, with some studies finding no advantage in using this instructional strategy ( Griffin, Malone & Kameenui, 1995; Simmons, Griffin & Kameenui, 1988). Other studies have concluded that graphic organizers can have a positive effect on student learning (Hawk, 1986; Moore & Readence, 1984). Recent studies have indicated that graphic organizers are an effective means to impact positively on student achievement (Dunston, 1992; Herbst, 1995; Monroe & Pendergrass, 1997; Wiegmann, Rewey, Dansereau & Pitre, 1992). The results of this study will provide additional information to researchers to assist in resolving the debate in the literature on the validity of graphic organizers as an effective instructional strategy to improve student achievement.

Thus far, the authors of Thinking Maps® are aware of only two investigations that have attempted to validate their claims through an organized research-based approach. Both of these efforts were limited to the master's thesis level of intensity and scope. This study marked the first time that their claims regarding the efficacy of the program has been conducted at the doctoral level of investigation.

The researcher contacted the authors of the Thinking Maps® program to discuss the feasibility of conducting a study of their program. They embraced the concept with certain reservations. Two main areas of concern emerged. Their first concern was expressed in regard to the effects that may occur due to any deviations from their prescribed program procedures as delineated in their training manual. They believe that any variation from these procedures would negate the effectiveness of the Thinking Maps® program. Second, they were concerned about the time frame of the proposed study. They were not sure if the strategy could be adequately evaluated in a seven month window as allotted by this study. Their claims of increased student achievement have been based on the program's usage over the entire school year. The researcher has found evidence from the literature that other studies on graphic organizers were conducted

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over shorter durations than that proposed in this study (Boothby & Alvermann, 1984; Hawk, 1986). The authors presume that any deviation in their program in terms of length of program application may diminish the positive significance the Thinking Maps® program would have on student achievement.

The researcher is especially interested in the connection the authors make for Thinking Maps® to the brain-based research. This aspect will be addressed in the review of the literature. The linkage the authors make to the brain-based research in support of how their program raises student's achievement scores on standardized tests is based on the work of Hyerle (1996a).

The brain-based research literature maintains that by understanding how the brain works, educators will be able to redefine learning through a different manner of teaching. Sylwester (1997) states:

> We are now confronting an explosion of new information about the workings of our brain that will profoundly affect educational policy and practice. Yet our profession, oriented as it is toward the social and behavioral sciences with only a limited understanding of biology and cognitive science, stands unready at the moment to take advantage of this learning revolution (p. 6).

In the preceding statement, Sylwester addresses the central focus of this study and provides the context for the significance the study will have for educators. He maintains that the gap between the research findings on the brain and the application of this information to the classroom will perplex those who hope to use the emerging field of brain-compatible learning to revolutionize the way educators approach instruction. What if teachers could rely on cognitive science to guide their practice like physicians rely on modern biology? Cognitive research on problem solving has revealed how we acquire and orchestrate knowledge and skills, gradually becoming more expert in the process, as we work in a subject area (Bruer, 1997). With the advances in neurological research, we do not have to adhere to Skinnerian models that explain everything we do through behavior alone (Wolfe, 1995).

However, this revolution of thinking about learning will present some key administrative issues that educators must confront in order to derive benefit from the abundance of research being conducted on the brain. New programs that promote their connection to the brain-based research are emerging to take advantage of the paradigmal shift in teaching and learning. The

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subject of this proposed study, the Thinking Maps® program, purports to be derived from the recent findings in brain research (Implementation and Assessment Guide, 1997). The program's authors cite statistics to demonstrate the program's ability to improve student achievement, but they provide no accompanying data to allow for accurate evaluation of their claims (Hyerle, 1996b). No data exists to disaggregate how the program affects race, gender, or previous achievement level of students. Some studies in the literature involving graphic organizers deal with these variables (Stone, 1982; Herbst, 1995), but the authors of Thinking Maps® have not provided information on how their product impacts these domains. Therefore, this study will be designed to assist educators in evaluating the worth of programs like Thinking Maps®, which are increasing in popularity due to the educational communities interest in brain research.

## Research Questions

The central research question the investigator seeks to answer is, do Thinking Maps® function to improve student achievement? The overall research question becomes, is there a difference between groups (fourth-grade students using Thinking Maps® instruction and fourth-grade students not using Thinking Maps® instruction) with regard to student achievement in math, language and reading, as measured by the Stanford Achievement Test? Under that umbrella, additional research questions will be formulated to address each of the independent variables, gender, race, and previous achievement level.

What is the effect of the use of Thinking Maps® in fourth-grade classrooms on gains in math, reading, and language as measured by the Stanford Achievement Test?

What is the effect of the use of Thinking Maps® on previous achievement (low, middle, high) in fourth-grade classrooms on gains in math, reading, and language as measured by the Stanford Achievement Test?

What is the effect of the use of Thinking Maps® with respect to race on gains in math, reading, and language as measured by the Stanford Achievement Test?

What is the effect of the use of Thinking Maps® with respect to gender on gains in math, reading, and language as measured by the Stanford Achievement Test?

What are the effects of the use of Thinking Maps® on the interactions between the level of previous achievement and race, level of previous achievement and treatment, level of previous

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achievement and gender, gender and treatment, gender and race, and treatment and race on gains in fourth-grade classrooms in math, reading, and language as measured by the Stanford Achievement Test?

## Definition of Terms

For the purposes of this study, the following terms are defined:

Advance Organizer - a specialized text passage introduced prior to the student's assignment of a reading lesson that includes information designed to assist the student in understanding the text to be read.

Graphic Organizer - (GO) a visual display of conceptual information designed to convey enhanced meaning or understanding of learned material.

Thinking Maps® - a systematic representation of a common language depicted by eight structured graphic organizers designed to enhance understanding of a concept or construct.

Achievement - as measured by the mathematics, reading and language scaled scores on the Stanford Achievement Test (Ninth Edition), a standardized test of achievement, employing national norms, used to assist in various educational practices such as student placement.

Visual argument - a process of transmitting ideas through a spatial arrangement of words, rather than through the written language.

## Limitations

The major limitation (Campbell & Stanley, 1963) of the study involved the small numbers in the samples and populations. Due to circumstances beyond the control of the researcher, additional teachers and students could not be included in the treatment group. This may pose a threat to the external validity of the study.

## Outline of the Document

Chapter One gives the reader an introduction to the purpose and significance of the study, with a brief explanation of the Thinking Maps® program. Chapter Two presents a review of the literature pertaining to the brain-based research to familiarize the reader with the context for understanding Thinking Maps® . In addition, an overview of the history of graphic organizers, the family of visual tools that led to the creation of Thinking Maps®, is presented. Along with this theme, an in-depth review of graphic-organizer research pertaining to the parameters of the

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study was conducted.

In Chapter Three, the methodology section, an explanation of how the researcher proceeded to examine the Thinking Maps® program and test the hypotheses is explained. A quasi-experimental design (Campbell & Stanley, 1963) was used to determine if the Thinking Maps® program does improve student's standardized test scores as the authors of this instructional strategy claim. Interviews with the participating teachers were conducted at the conclusion of the study to determine classroom conditions. Attention was given to study design, samples and populations, treatment and control groups, and defining variables in this portion of the study.

Chapter Four addresses the results of the study, reports the findings of the research methods, and provides descriptive statistics in tabular form.

Chapter Five is concerned with discussion regarding conclusions, implications, and suggestions for future study emanating from this investigation.

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# APPENDICES

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# APPENDIX A

## SUPPLEMENTARY STATISTICAL ANALYSES

Table A 1

Group Statistics for t-test on Previous Achievement in Reading, Mathematics, and Language

| | School | N | M | SD | t |
|---|---|---|---|---|---|
| Preachr[a] | School A[d] | 41 | 607.24 | 36.40 | .41 |
| | School B[e] | 37 | 608.73 | 28.32 | |
| Preachm[b] | School A | 41 | 593.22 | 33.57 | .92 |
| | School B | 37 | 87.78 | 28.01 | |
| Preachl[c] | School A | 41 | 587.15 | 34.95 | .29 |
| | School B | 37 | 587.03 | 39.61 | |

[a] Preachr = pretest score mean for reading, [b]Preachm = pretest score mean for mathematics, [c]Preachl = pretest score mean for language, [d]School A = treatment school, [e]School B = control school

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Table A2

Tests of Between-Subjects Effects for Post-Achievement Reading with Previous Achievement in Reading as a Covariate

| Source | df | SS | MS | F | p |
|---|---|---|---|---|---|
| Corrected model | 8 | 62467.66 | 7808.46 | 15.09 | .00 |
| Intercept | 1 | 1838.46 | 1838.46 | 3.55 | .06 |
| Preachr[a] | 1 | 57294.71 | 57294.71 | 110.70 | .00 |
| School | 1 | 1386.84 | 1386.84 | 2.69 | .11 |
| Gender | 1 | 1309.15 | 1309.15 | 2.53 | .12 |
| Race | 1 | 114.23 | 114.23 | .22 | .64 |
| School x gender | 1 | 1007.20 | 1007.20 | 1.95 | .17 |
| School x race | 1 | 268.34 | 268.34 | .52 | .47 |
| Gender x race | 1 | 698.84 | 698.84 | 1.35 | .25 |
| School x gender x Race | 1 | 1130.06 | 1130.06 | 2.18 | .14 |
| Error | 69 | 35711.18 | 35711.18 | | |
| Total | 78 | 30876461.00 | | | |

[a]Preachr = previous achievement reading.

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Table A 3

Tests of Between-Subjects Effects for Post-Achievement Mathematics with Previous Achievement in Mathematics as a Covariate

| Source | df | SS | MS | F | p |
|---|---|---|---|---|---|
| Corrected model | 8 | 35806.38 | 4475.80 | 9.67 | .00 |
| Intercept | 1 | 9451.14 | 9451.14 | 20.42 | .00 |
| Preachm[a] | 1 | 30782.60 | 30782.60 | 66.52 | .00 |
| School | 1 | 1162.90 | 1162.90 | 2.51 | .18 |
| Gender | 1 | 2.73 | 2.73 | .01 | .94 |
| Race | 1 | 5.90 | 5.90 | .01 | .96 |
| School x gender | 1 | 202.80 | 202.80 | .44 | .51 |
| School x race | 1 | 59.54 | 59.54 | .13 | .72 |
| Gender x race | 1 | 103.50 | 103.50 | .22 | .64 |
| School x gender x race | 1 | .91 | .91 | .00 | .97 |
| Error | 69 | 31931.17 | 462.77 | | |
| Total | 78 | 29521337.00 | | | |

[a]Preachr = previous achievement mathematics.

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Table A 4

Tests of Between-Subject Effects for Post-Achievement Language with Previous Achievement in Language as a Covariate

| Source | df | SS | MS | F | p |
|---|---|---|---|---|---|
| Corrected model | 8 | 43429.71 | 5428.71 | 9.20 | .00 |
| Intercept | 1 | 14696.78 | 14696.78 | 24.91 | .00 |
| Preachl[a] | 1 | 40613.92 | 40613.92 | 68.83 | .00 |
| School | 1 | 223.23 | 223.23 | .38 | .54 |
| Gender | 1 | 950.70 | 950.70 | 1.61 | .21 |
| Race | 1 | 68.97 | 68.97 | .18 | .73 |
| School x gender | 1 | 181.73 | 181.73 | .31 | .59 |
| School x race | 1 | 861.31 | 861.31 | 1.46 | .23 |
| Gender x race | 1 | 2241.91 | 2241.91 | 3.80 | .06 |
| School x gender x race | 1 | 595.87 | 595.87 | 1.01 | .32 |
| Error | 69 | 40713.64 | 590.06 | | |
| Total | 78 | 28987289.00 | | | |

[a] Preachl = previous achievement language.

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# APPENDIX B

## DIAGRAMS OF THE EIGHT Thinking Maps®

In this section the eight Thinking Maps® used in the program are presented. Permission was granted by the owners of the Thinking Maps® program to use these diagrams.



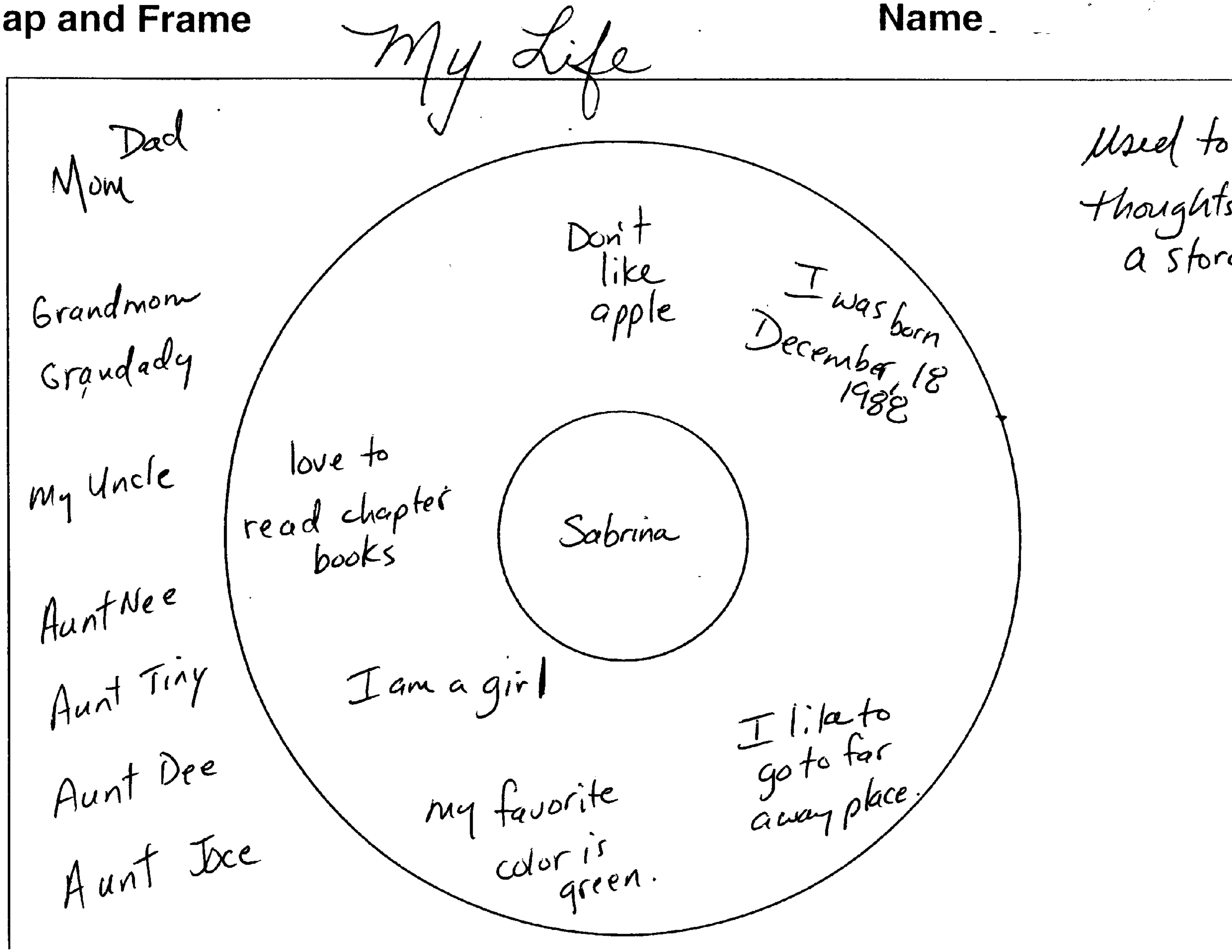
# APPENDIX C

## EXAMPLES OF STUDENT CONSTRUCTED Thinking Maps®

In this section examples of student constructed Thinking Maps® are presented. These were collected from the fourth-grade classes in School A.

# Circle Map and Frame

Name ______

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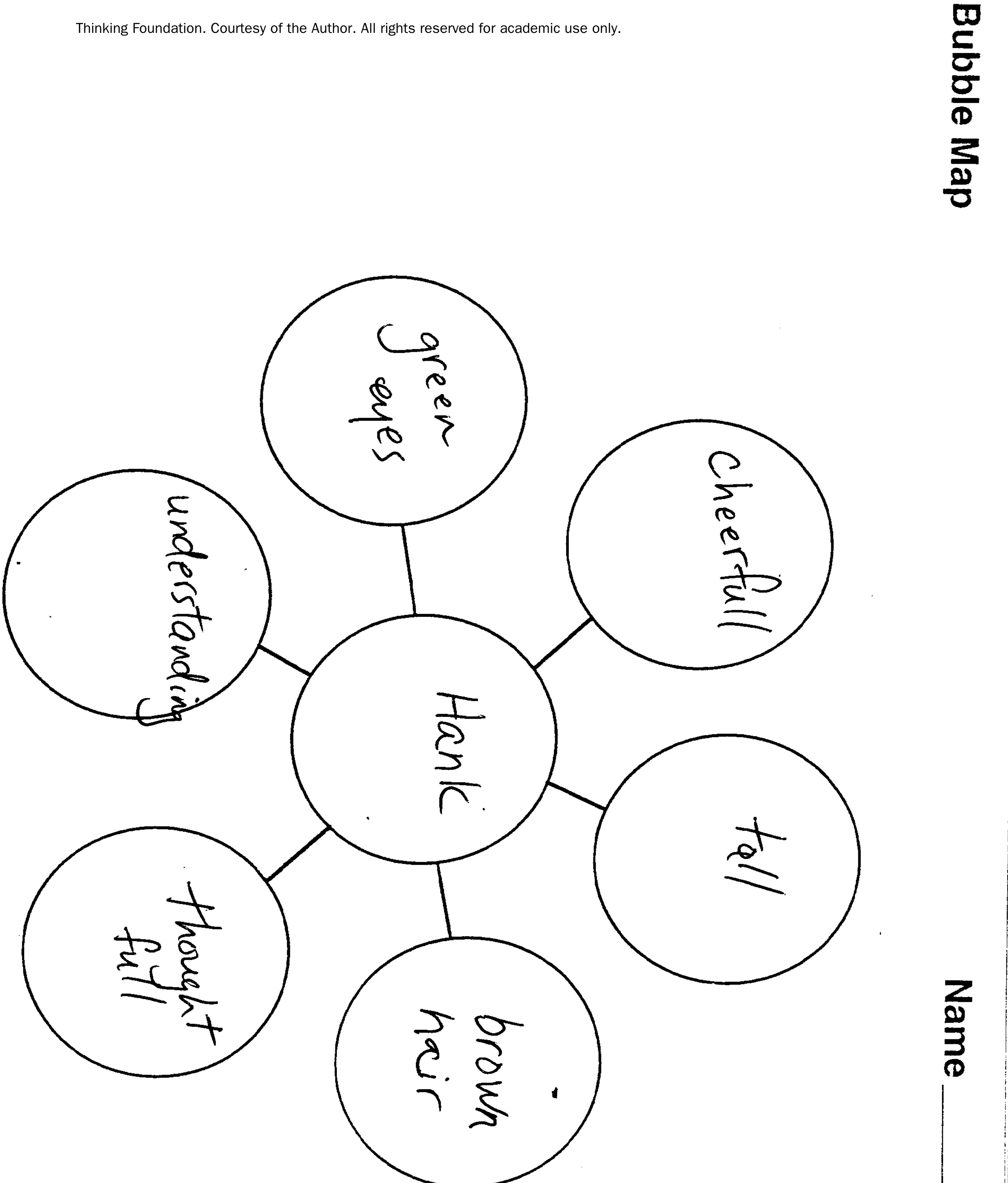

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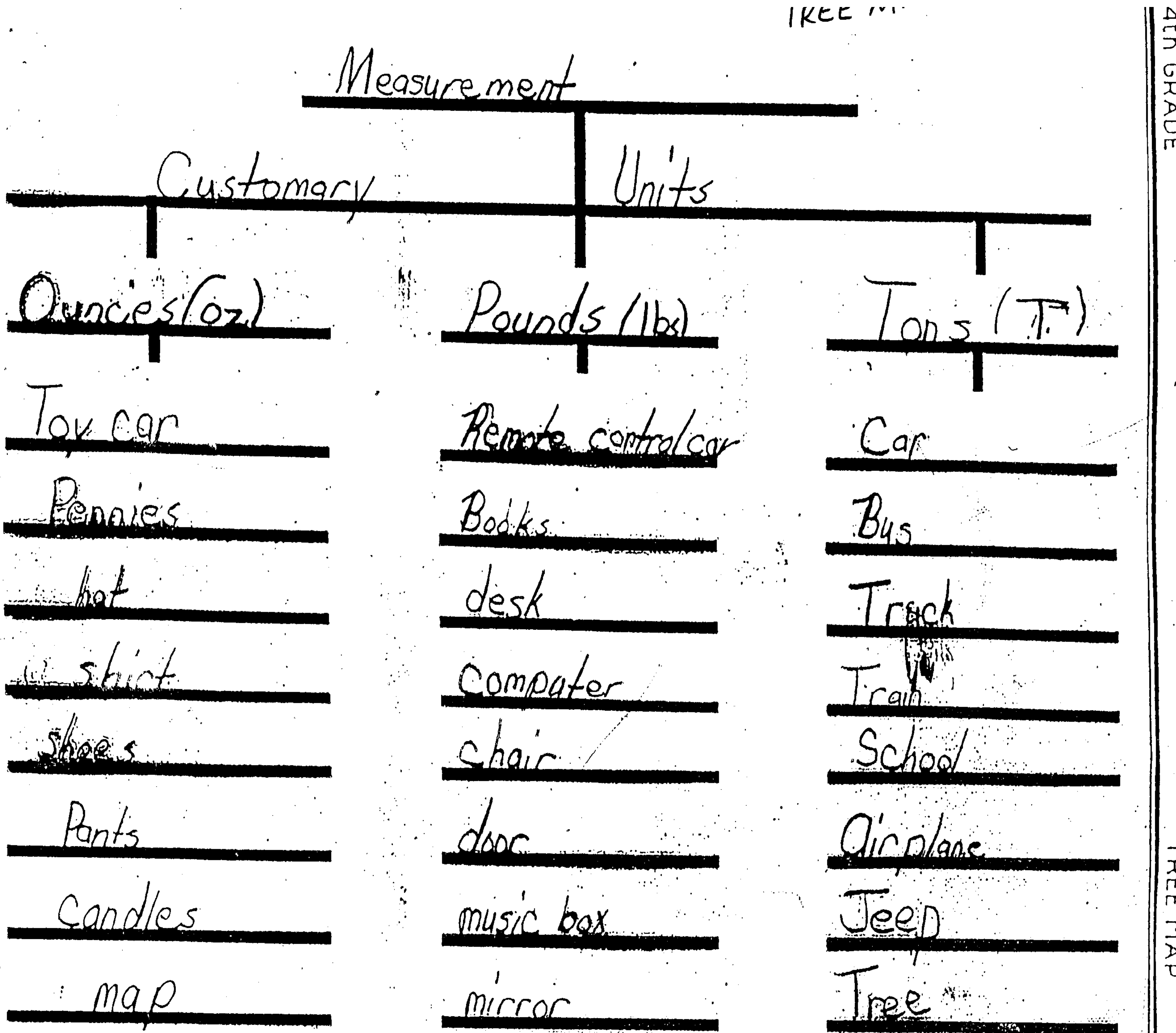


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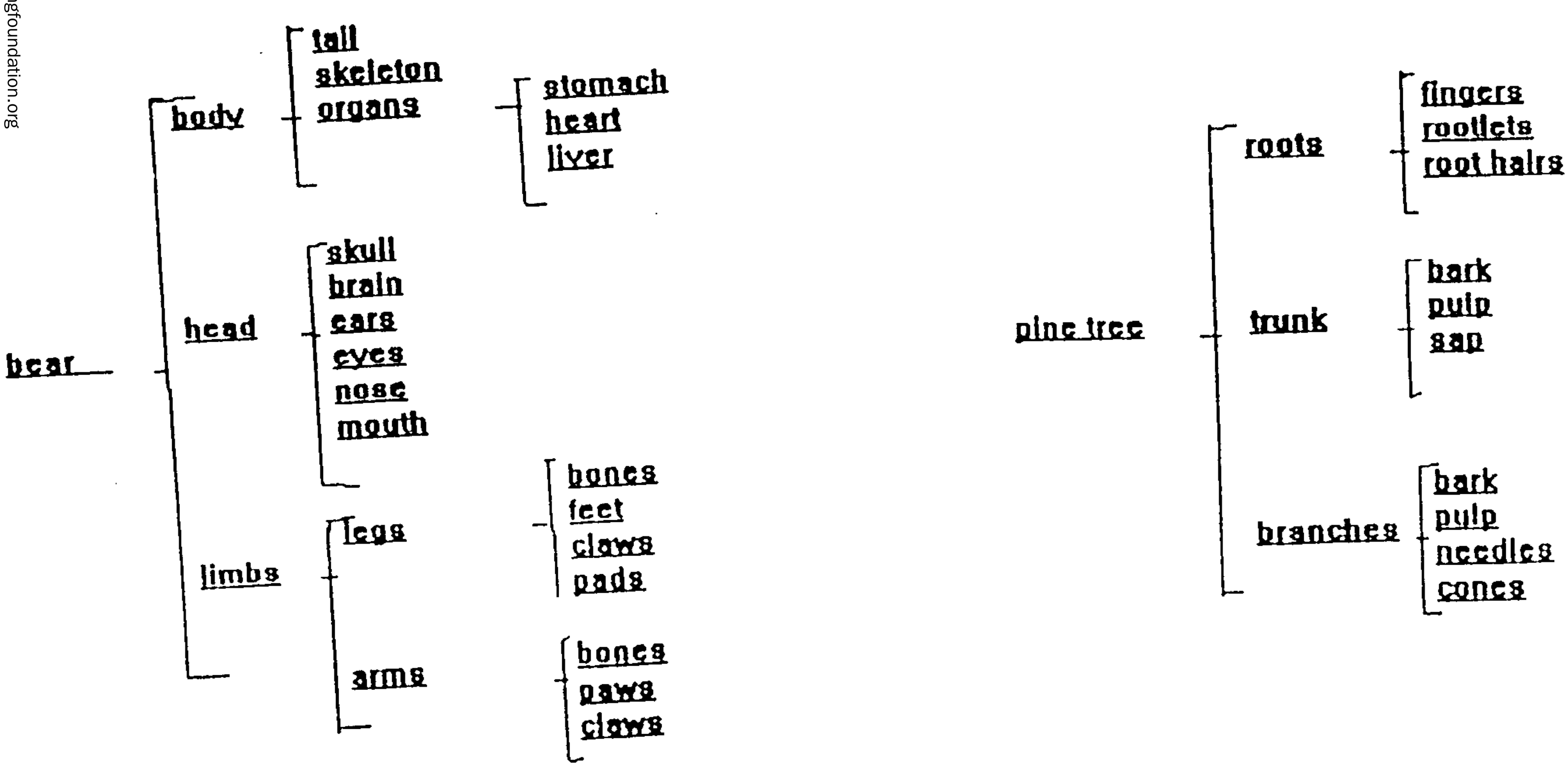
# A Brace Map composed by student on the computer



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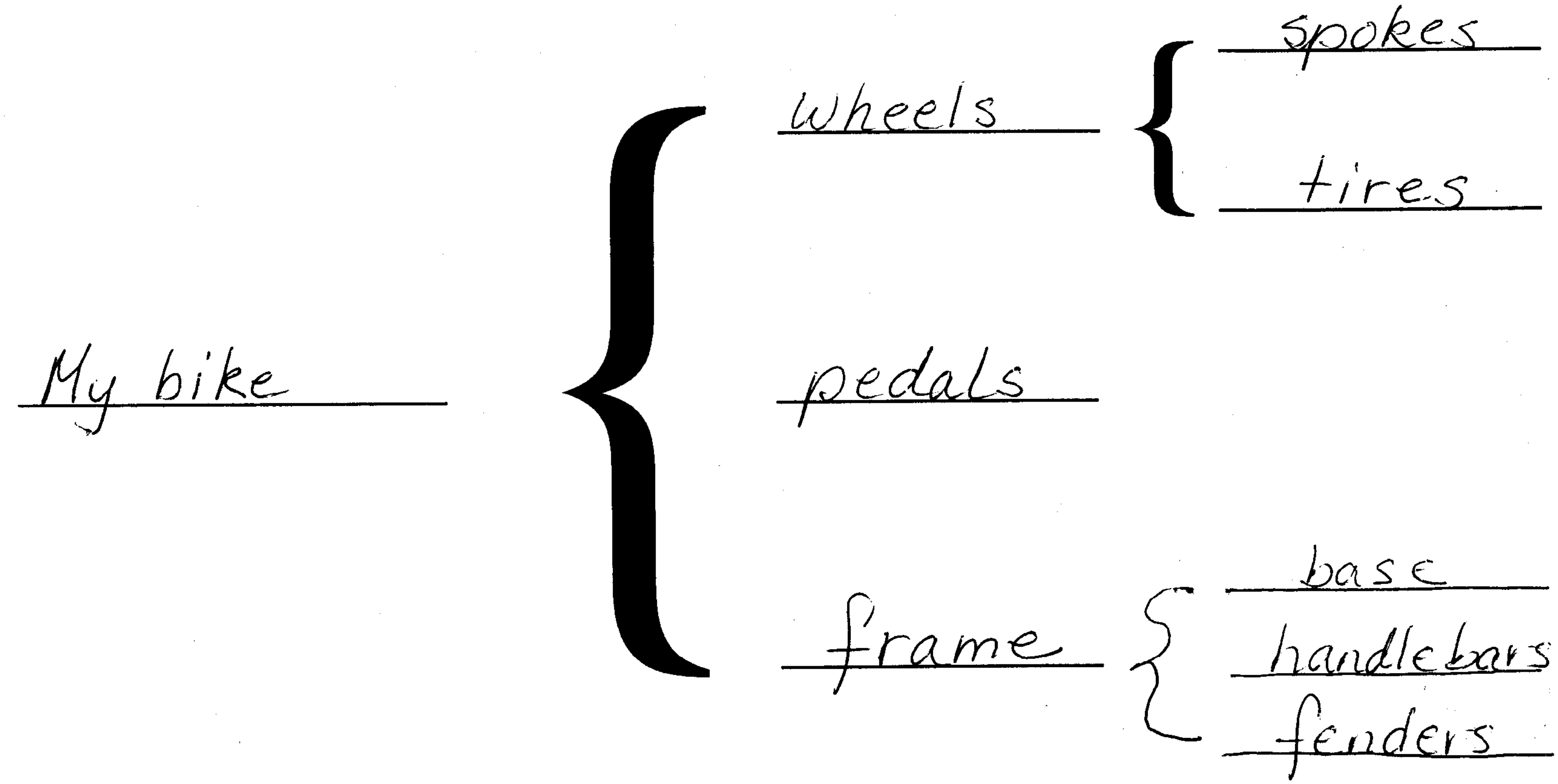
## Brace Map

Name ______ March 1999



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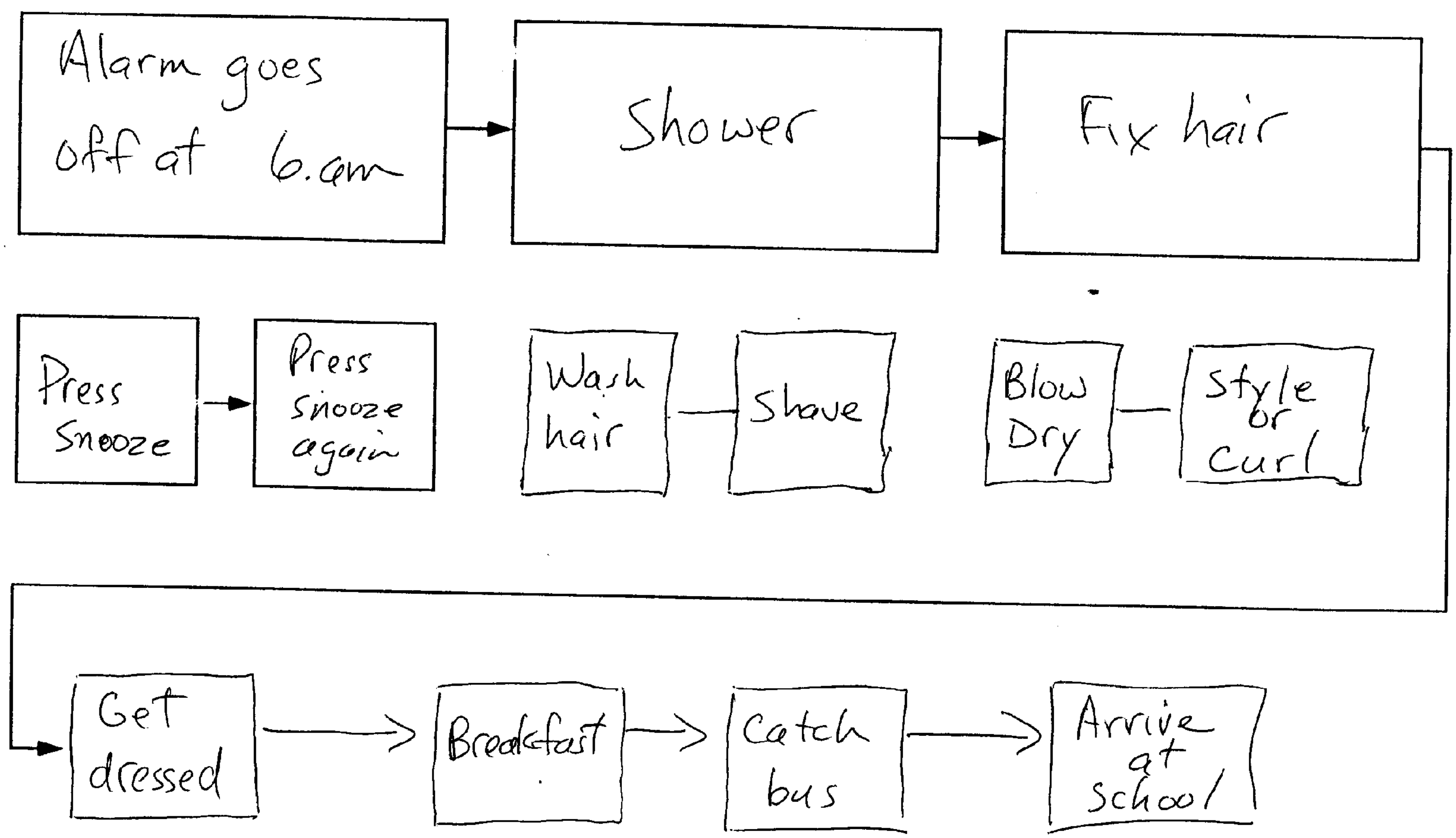
**Flow Map** A Typical Morning **Name** ____________




**Flow Map for Sequencing Stages and Substages of Events**



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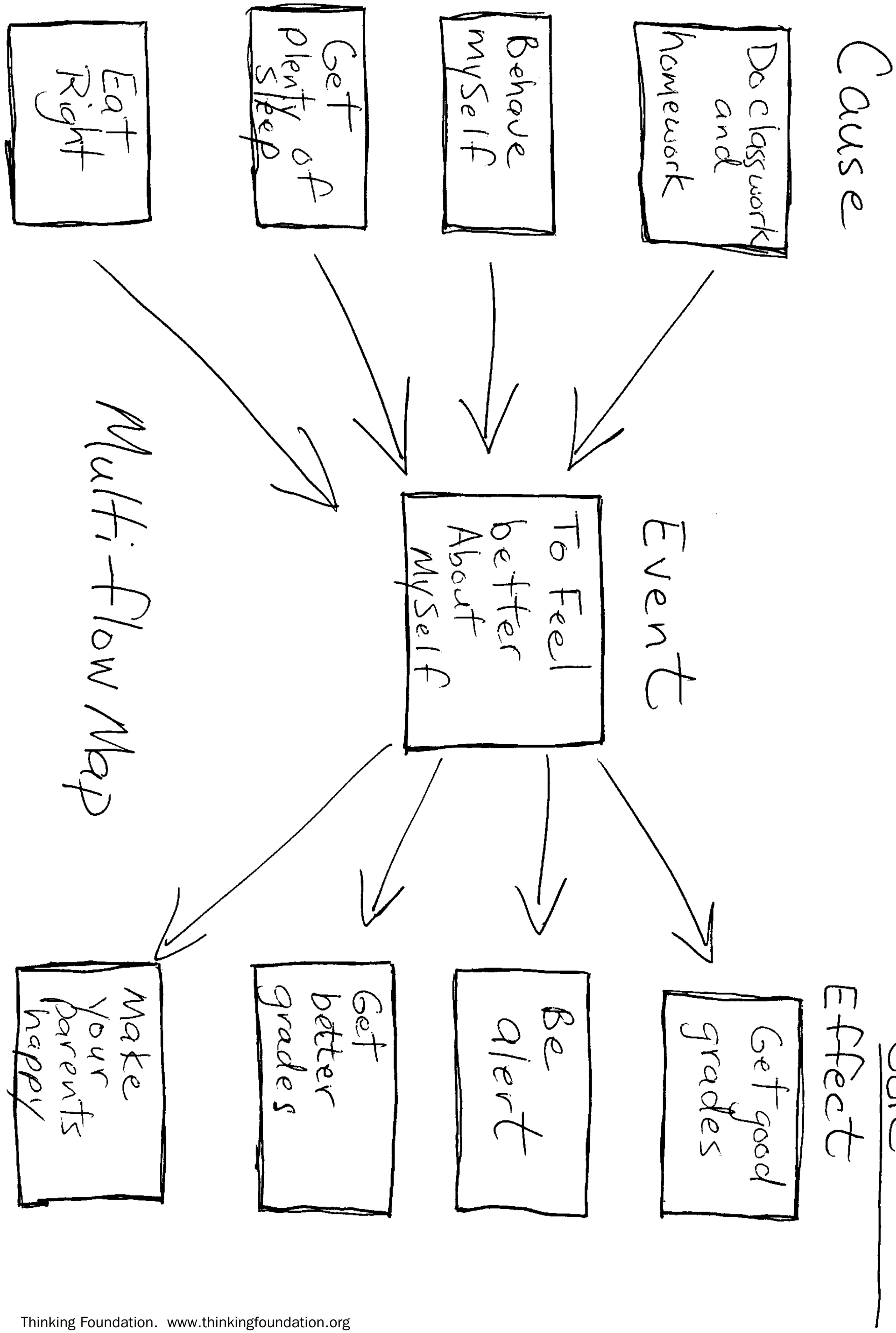

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**Bridge Map** **Name** ______________

Decimals

*RELATING FACTOR*

.3

$\frac{3}{10}$

as

.47

$\frac{47}{100}$

**Bridge Map for Seeing Analogies (similar relationships between ideas)**



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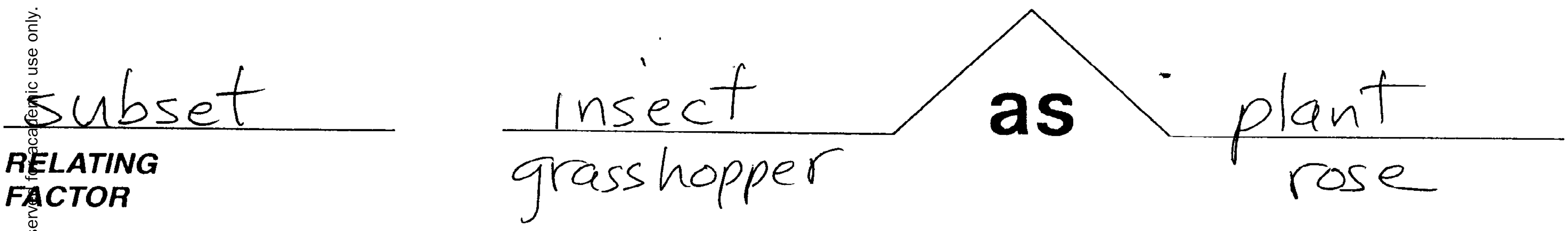
# Bridge Map

Name ____________________




**Bridge Map for Seeing Analogies (similar relationships between ideas)**



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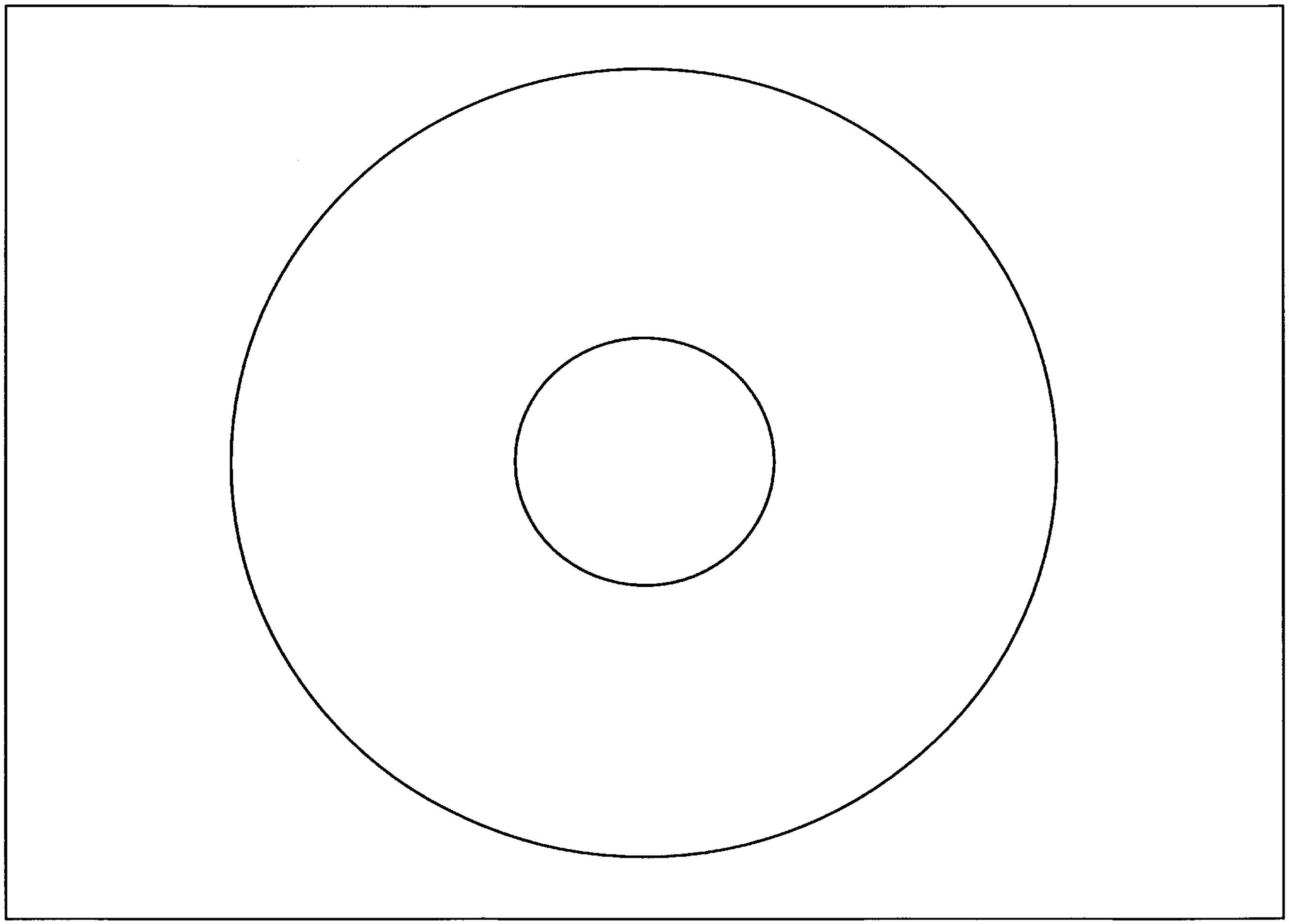
## Circle Map and Frame

Name ____________________



**Circle Map for Defining in Context • Frame for Frame of Reference**



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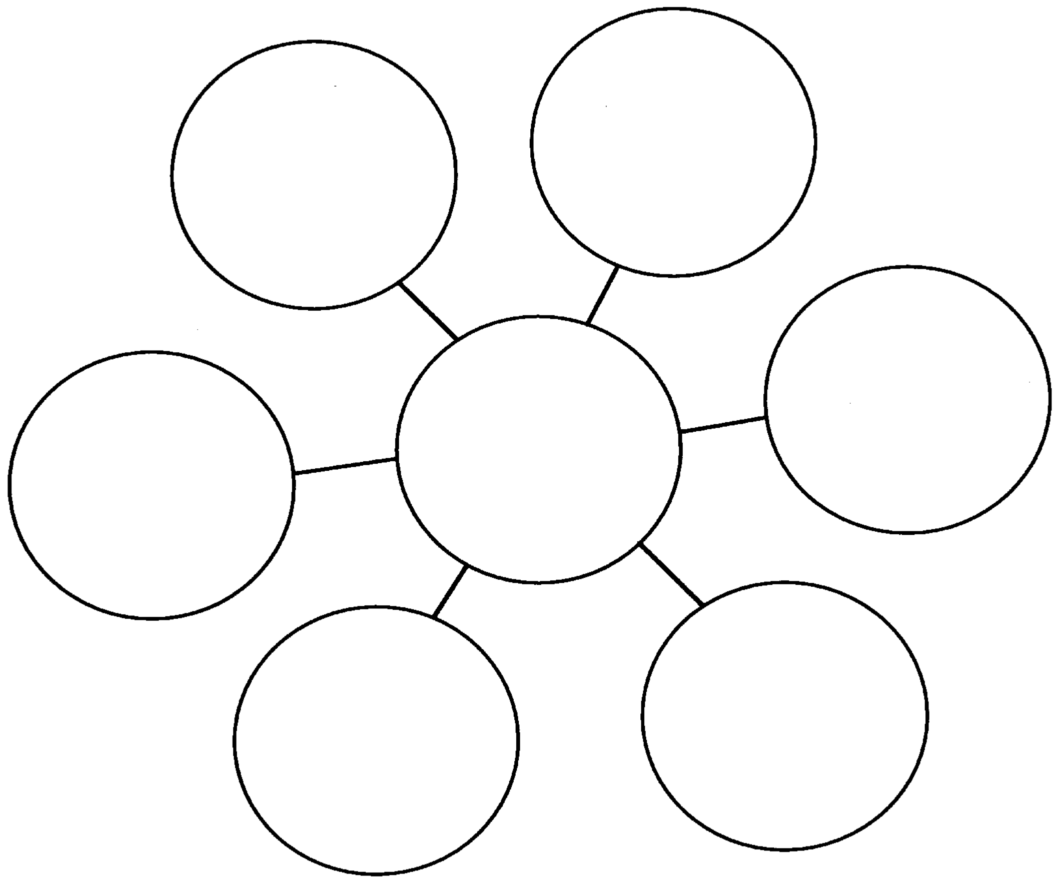
## Bubble Map

Name ____________________



**Bubble Map for Describing Using Adjectives and Adjective Phrases**



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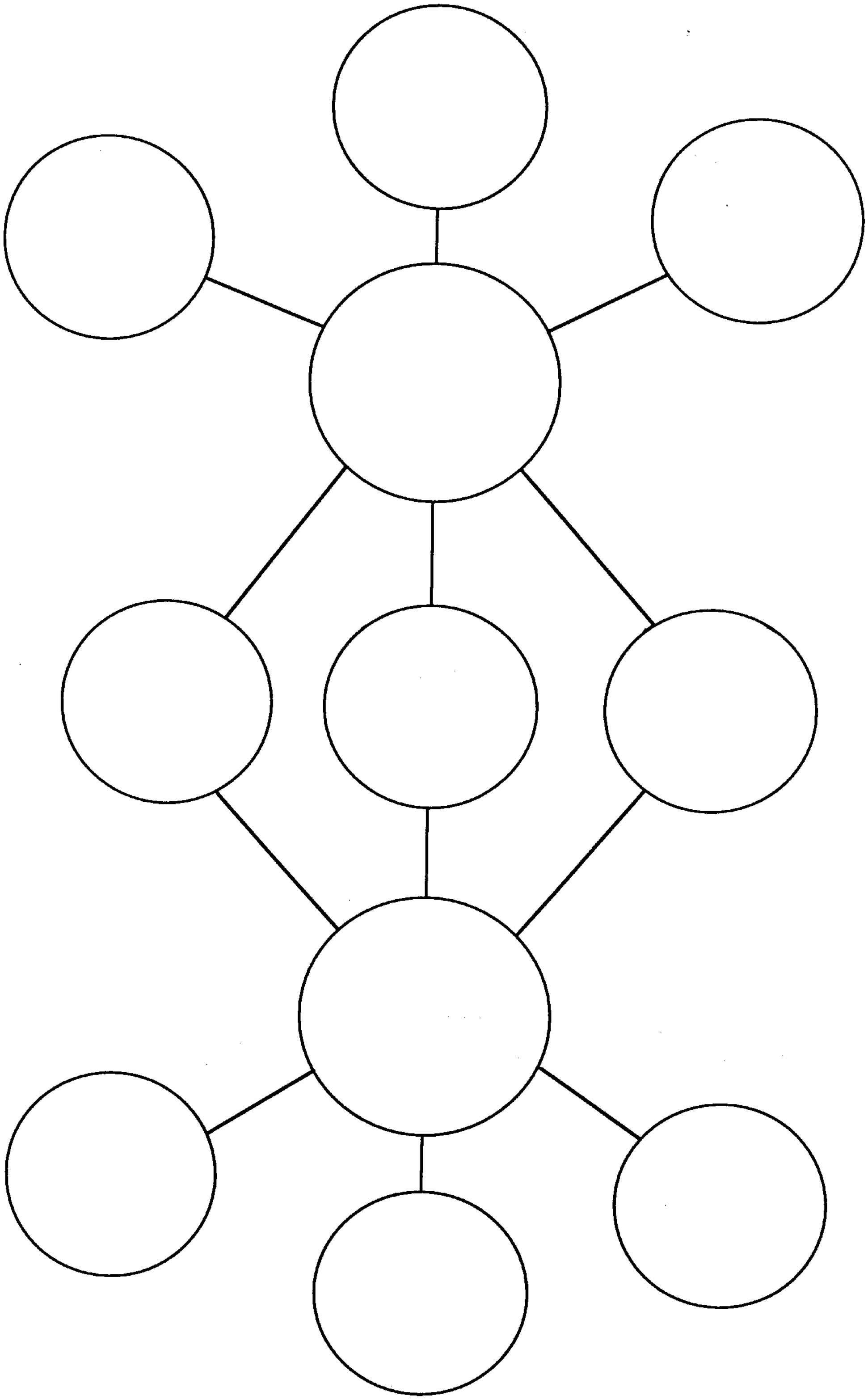

**Double Bubble Map for Comparing (similarities) and Contrasting (differences)**

2-17

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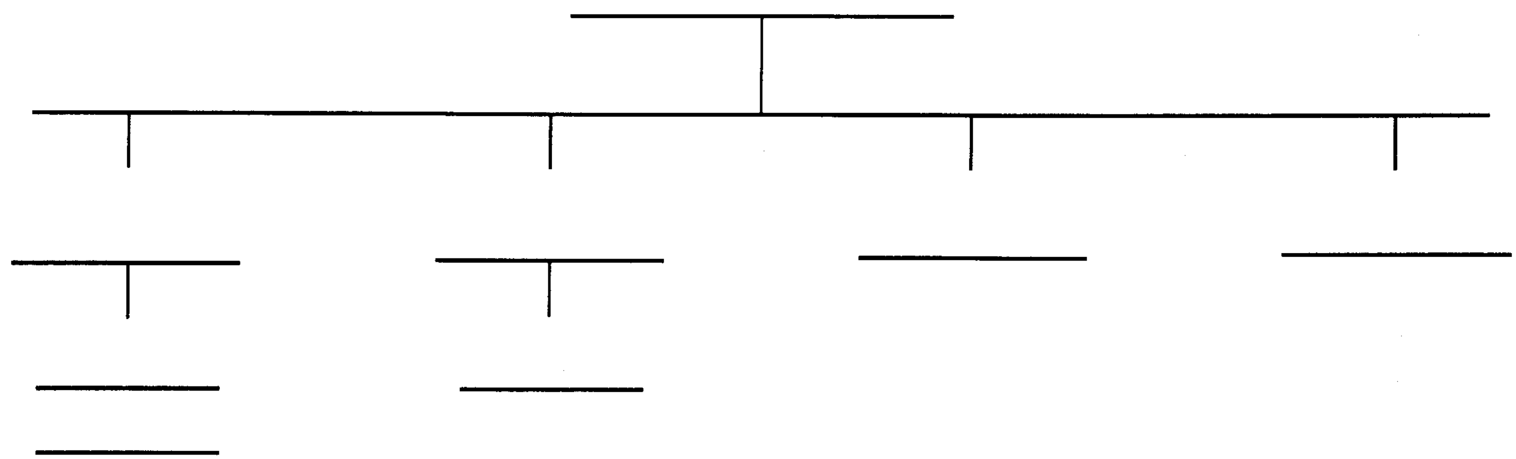
# Tree Map

Name ______________



2-21 **Tree Map for Classifying and Grouping Main Idea, Supporting Ideas, and Details**

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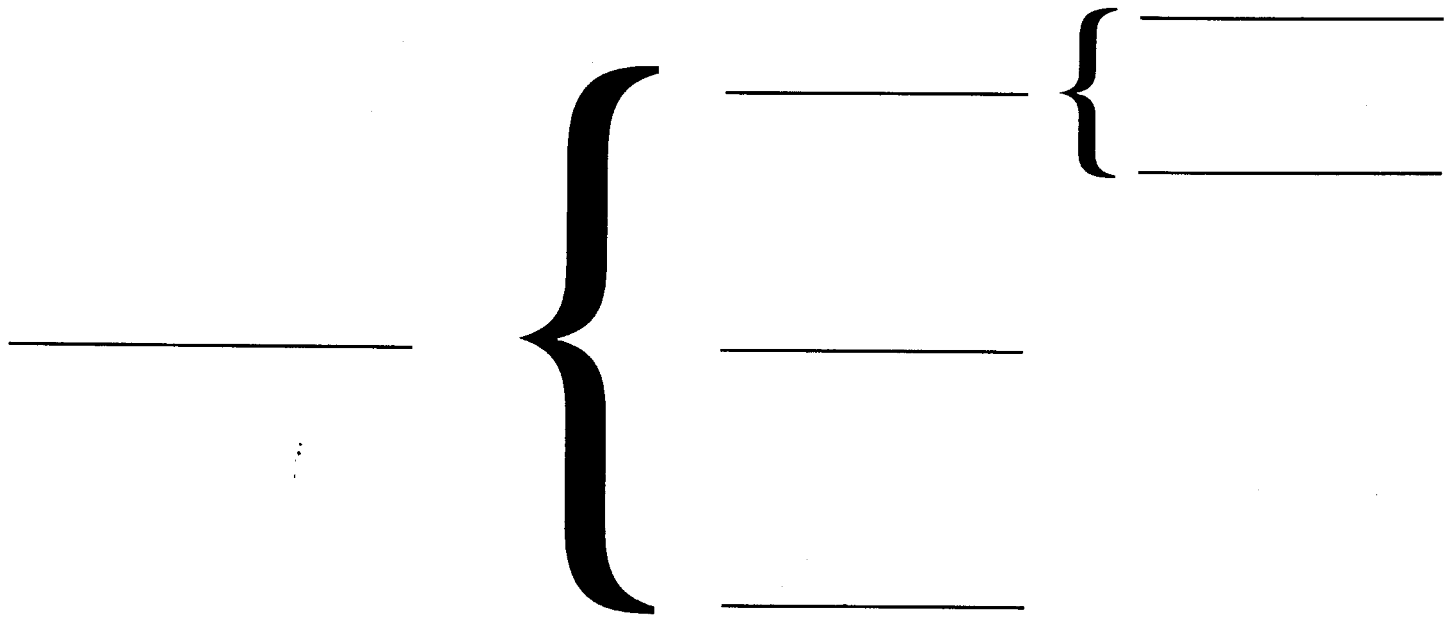
# Brace Map

**Name** ______________________



**2-25** **Brace Map for Physical Analysis of Whole, Parts, and Subparts of Objects**

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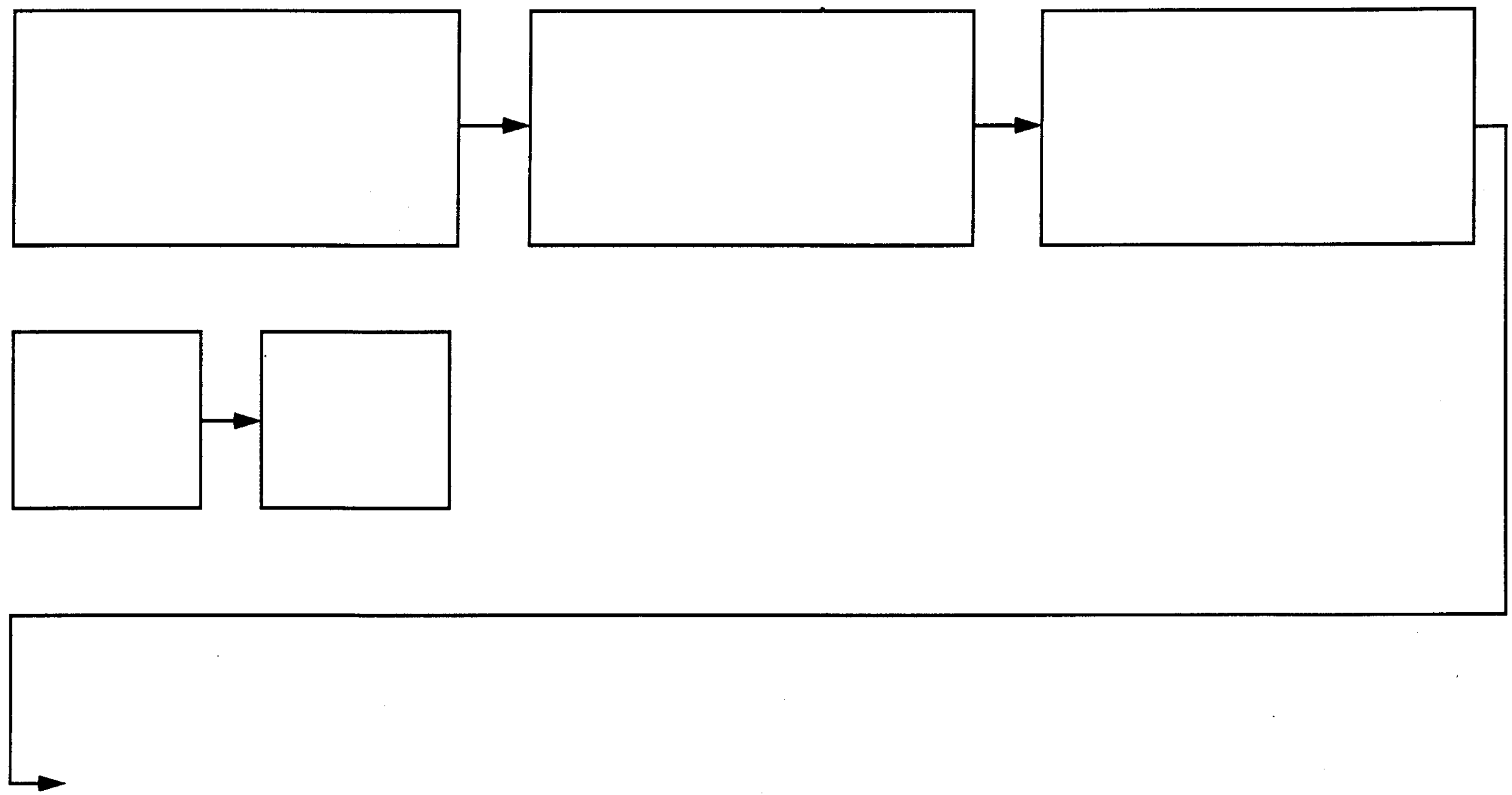
# Flow Map

Name ______________________



Flow Map for Sequencing Stages and Substages of Events



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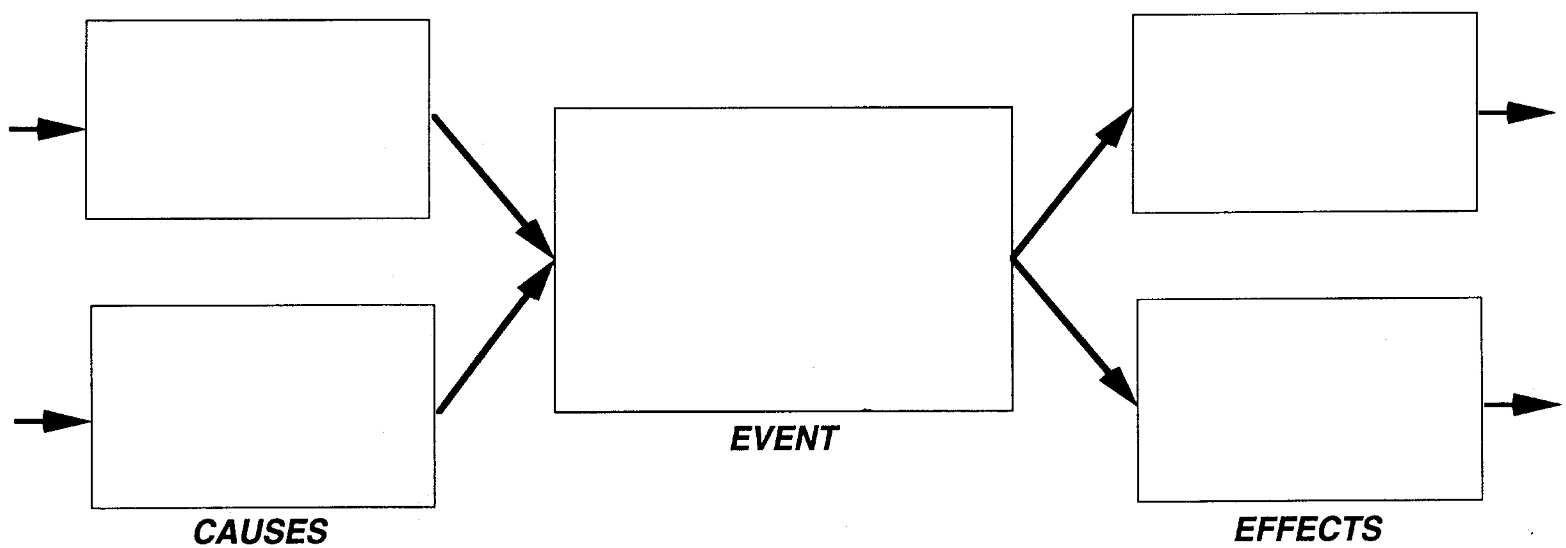
# Multi-Flow Map

Name ____________________




Multi-Flow Map for Causes and Effects



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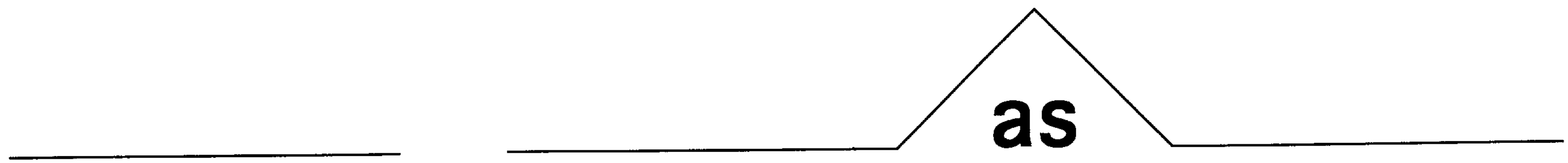
# Bridge Map

Name ____________

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**Bridge Map for Seeing Analogies (similar relationships between ideas)**

2-37

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# Vita

## Samuel Ferebee Leary, Jr.

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Phone: 757-547-2722

**Work:** Chesapeake Public Schools
Chesapeake, VA 23322
Phone: 757-547-0153
Fax: 757-547-1346

**Education:**

*Virginia Tech, Ed.D., 1999.*
Graduated from doctoral program in educational administration in December, 1999. Completed dissertation research on the effect of Thinking Maps® on elementary student achievement.

*Virginia Tech, Ed.S., 1998*.
Completed requirements for Educational Specialist degree in December, 1998. Completed course work in Educational and Administration Theory, School Law, School Finance, School Personnel Administration, School Facilities, Administration of Curriculum, Special Education, and Research and Statistics.

*University of Virginia, M.Ed 1979.*
Master degree in Educational Administration conferred in 1979. Certified in secondary administration through the Administration Internship program.

*Old Dominion University, B.S. Ed., 1973*.
Bachelor of Science degree in secondary education with teaching major in biology and general science. Participated on the track and swimming teams (co-captain). Outstanding Swimmer Award 1972.

**Work Experience:**

*Curriculum and Instruction Supervisor, Chesapeake Public Schools, 1995-present.*
K-12 supervisor for curriculum and instruction with a variety of responsibilities, including summer school for the division, various alternative education programs, and coordinator of the departments' activities. Chaired numerous committees and task forces, evaluated programs, and prepared budget.



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*Staff Assistant in Instruction, Chesapeake Public Schools, 1991-1995.*
Served as assistant to the Assistant Superintendent for Instruction. Various responsibilities including chairing committees, supervising other supervisors, developing budget and action plans, evaluating programs, implementing programs, and school improvement.

*Principal, Truitt Junior High School, Chesapeake Public Schools, 1984-1991.*
Principal of 550-student junior high school serving grades 7-8. Responsible for all aspects of school operation including instructional leadership, planning and implementation, staff selection and evaluations, student placement and discipline, and plant supervisor and finance. Led movement in school division to the middle school concept.

*Assistant Principal, Indian River High School, 1979-1984.*
Assistant principal for 1300-student high school serving grades 10-12. Responsible for all aspects involving the sophomore class, including student discipline, teacher evaluation, and plant maintenance and transportation. Summer school principal in 1984 for the school division.

*Science Teacher, Truitt Junior High School, 1973-1978.*
Taught Earth Science to eighth graders. Coached wrestling, track and football. Served on numerous committees within the school. Selected by the school division to participate in the Masters' Degree Administrative Internship program at UVA.



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