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ABSTRACT

This study investigated the effect an advanced organizer, a post organizer, or knowledge of a behavioral objective has on learning the mathematical concept of network tracing. Self-instructional booklets on network tracing were given to eighth grade students. The booklets were designed so that the instruction and posttest could be completed within a regular class period. Pages for the advanced organizer, post organizer, and knowledge of a behavioral objective varied according to the experimental treatment in a 2x2x2 factorial design. A retention test was given one week later. Analysis of variance was used to examine the data. A significant negative main effect for post organizers was found on the retention test. Similar but not significant results were found on the learning test. (Author/FL)

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EFFECT OF AN ADVANCED ORGANIZER, A POST ORGANIZER, OR KNOWLEDGE OF A BEHAVIORAL OBJECTIVE ON ACHIEVEMENT AND RETENTION OF A MATHEMATICAL CONCEPT

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ABSTRACT

Objectives and Methods

This study investigated the effect an advanced organizer (AO), a post organizer (PO), or knowledge of a behavioral objective (KBO) have on learning the mathematical concept of network tracing.

Self-instructional booklets on network tracing were given to eighth grade students. Booklets were designed so that the instruction and posttest could be completed within a regular class period. Pages for the AO, PO, and KBO varied according to the experimental treatment in a 2 x 2 x 2 factorial design. A retention test was given one week later. ANOVA was used to examine the data.

Results

A significant negative main effect ($p < .10$) for post organizers was found on the retention test. Similar, but not significant result were found on the learning test.

SE 010 793

A paper presented to Division C at the Annual Meeting of the American Educational Research Association, New York City, New York, February 4-7, 1971.

EFFECT OF AN ADVANCED ORGANIZER, A POST ORGANIZER,

OR KNOWLEDGE OF THE BEHAVIORAL OBJECTIVE ON

ACHIEVEMENT AND RETENTION OF A MATHEMATICAL CONCEPT [1]

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The purpose of this study was to determine the effects an advanced organizer (AO), a post organizer (PO), or the knowledge of the behavioral objective (KBO) have on the learning or retention of a mathematical concept.

The term "advanced organizer" is used here to identify information given to students prior to instruction which relates the unfamiliar new material to be learned to the general background a student is assumed to have. An advanced organizer is designed to bring to the students' attention assumed previous knowledge which is related to the content to be learned.

The term "post organizer" is used here to refer to information given to students after instruction which relates what has just been learned to the students' general background knowledge. A post organizer is designed to facilitate retention of the new material by showing how the new material just learned relates to prior knowledge.

The term "knowledge of the behavioral objective" is used here to identify information given to a student prior to instruction which informs him about anticipated learning outcomes he can expect to acquire from the instruction. Student knowledge of the behavioral objective of the lesson

[1]The work reported in this paper was supported by a grant from the Council on Faculty Research, Eastern Illinois University.

is designed to increase the probability that a student rehearses certain associations acquired prior to the presentation of the lesson and that the occurance of these associations facilitates the learning of related new material.

Research studies by Bauman, Glass, and Harrington (1969) and Romberg and Wilson (1970) have shown that advanced organizers, post organizers, and knowledge of behavioral objectives facilitate learning and retention. However, Romberg and Wilson found a significant interaction between advanced organizers and post organizers on retention of a mathematical concept.

Since the advanced and the post organizer each provides information to link the new material to already existing cognitive structures which the students may possess, it was predicted that each would facilitate retention of material. It was also predicted that knowledge of the behavioral objective would facilitate both learning and retention. The results of the study by Romberg and Wilson gave reason to doubt that the three effects would be additive.

Subjects

The subjects were 104 students enrolled in the six eighth-grade mathematics classes at Marshall Junior High School, Marshall, Illinois. All six classes had the same teacher. Classes were grouped homogenously.

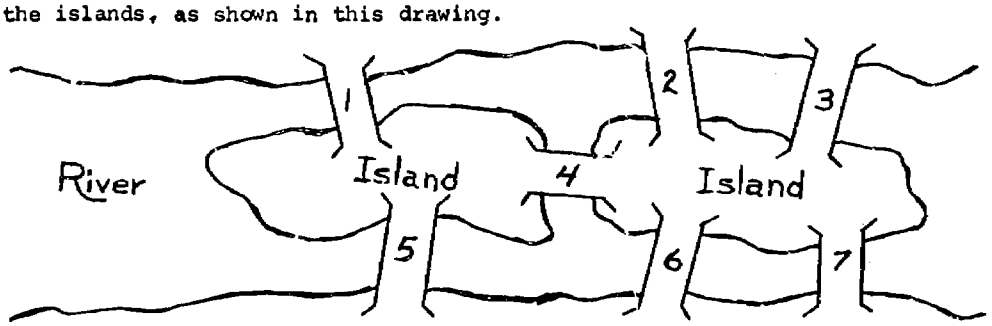
Materials

The new material to be learned consisted of five pages of self-instructional materials on network tracing--a mathematical concept unfamiliar to the students. The material was adapted by the author from Johnson and Glenn (1960). Each page required several short responses from the student. (See Appendix.)

This topic was selected because it was felt that while network tracing was relatively unfamiliar to eighth-grade students, the material would be interesting and could be completed within one class period.

The advanced organizer consisted of three paragraphs and a drawing as follows:

> In the eighteenth century, in a little German town, Sunday strollers were fond of wolking along the banks of the river. The river wandered through the town and was crossed by seven bridges. These bridges ran from each bank of the river to two islands in the river, with one bridge joining the islands, as shown in this drawing.



> One day a man asked his friend this question: "Can you take a Sunday walk so that you cross each of our seven bridges and you cross each bridge only once?" The problem interested the neighbor and soon caught the interest of many other people in town. The people tried very hard to answer the question, but no one was able to. Finally, a famous mathematician was able to answer the question.
>
> The mathematician used just lines and dots to represent the above drawing. He let a line stand for each bridge and a point for each island or river bank. He found that you can tell if the question could be answered by looking at how many lines met at each point.

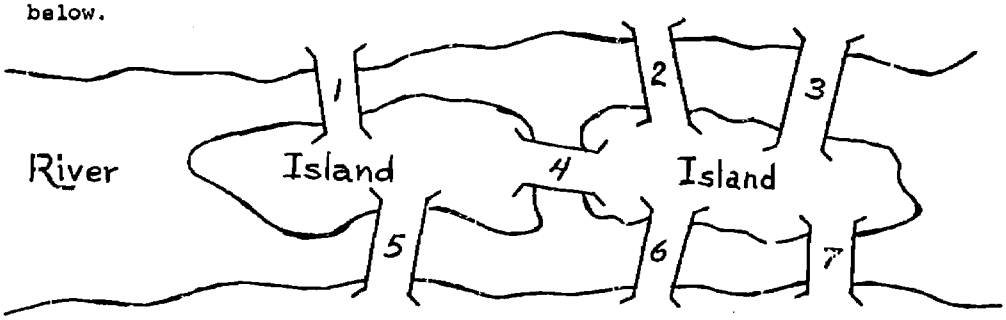
The advanced organizer was designed to get students to relate their knowledge of geography, geometry, and number parity to the concept of network tracing.

The behavioral objective consisted of one sentence:

> Upon completion of the study of this booklet you are expected to know the general rule for tracing networks and to be able to solve simple problems based upon the application of this rule.

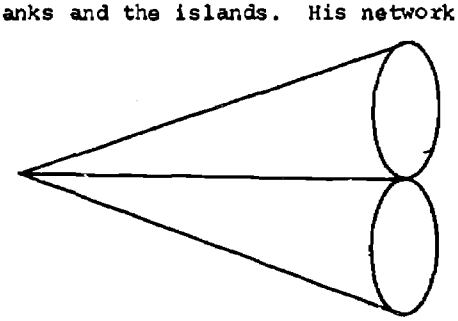
The post organizer consisted of four paragraphs and two drawings as follows:

An eighteenth century German town had seven bridges which ran from each bank of a river to two islands in the river. One bridge joined the islands. This is shown in the drawing below.



The people in the town wondered if it was possible to take a walk and cross each of the seven bridges only once. For a long time no one was able to solve the problem.

A famous mathematician used a network to represent the drawing above. His network used line segments for bridges and verticies for the river banks and the islands. His network is shown below.



As you can see, all of the vertices are odd vertices. So, by the rule you found for networks it was not possible for the people in the town to take a walk and cross each bridge exactly once.

The content of the post organizer was designed to be similar to that in the advanced organizer. The post organizer was to emphasize relationships between what was just learned and the students' background knowledge.

Two similar 12-item multiple-choice tests were constructed--one to measure immediate learning and one to measure retention. The first part of each test measured whether students could tell is a vertex was even or odd. The remainder of each test measured whether the students could determine whether the network was traceable. The content validity of the tests

reliability coefficients for the learning and retention tests as determined by the Kuder-Richardson No. 20, were .63 and .60 , respectively.

Each student studied one of the eight variations of booklets prepared for the study. All booklets contained the self-instructional materials on network tracing and the learning test. The booklets varied in the eight possible arrangements of including or not including each of the three types of additional information: advanced organizer, post organizer, or behavioral objective.

Procedures

Each booklet was assigned a number with the hundreds digit designating to which of the eight variations each booklet belonged. A table of random numbers was used to order the eight variations and to determine the initial booklet. A package of booklets was prepared for each of the six classes participating in the study. Instructions were given to the teacher asking that he distribute the booklets sequentially by rows. This gave a close approximation to randomization. Thus, all eight variations of booklets were studied simultaneously in the same room. At the end of the instructional period the teacher was instructed to collect the booklets, return them to the investigator, and refrain from discussing the lesson with the students. Exactly one week later the retention test was administered and returned to the investigator.

Before anazlyzing the data ten cases were randomly discarded (leaving data from 104 students) in order to use an equal-cell ANOVA (13 students per cell).

RESULTS

The data for both the learning and retention tests were submitted to a 2x2x2 fixed effects analysis of variance (ANOVA). The three factors

in the ANOVA were: (1) advanced organizer, (2) post organizer, and (3) knowledge of behavioral objective.

Table 1 contains the mean and standard deviation for each of the eight variations on the learning test as well as for all students who did or did not receive each treatment.

Insert Table 1 here

Table 2 contains the ANOVA for scores on the learning test.

Insert Table 2 here

None of the main effects or interactions were significant although the variance due to post organizer was suggestive of a trend.

Table 3 contains the mean and standard deviation for each of the eight variations on the retention test as well as for all students who did or did not receive each treatment.

Insert Table 3 here

Table 4 contains the ANOVA for scores on the retention test.

Insert Table 4 here

On the retention test scores, the F-statistics were significant ($p<.10$) for the main effect due to the post organizer. An examination of Table 3 indicates that the presence of a post organizer seemed to hinder the retention of the mathematical concept of network tracing. No F-statistics were significant on the learning test, but the one for the post organizer was the strongest. Thus, even though no significant

differences were found on the learning test, the trend there supported the significant effects found on the retention test.

CONCLUSION

The results of this study fail to support the conclusion of Bauman, Glass, and Harrington that "placing an 'organizer' after a lesson has a facilitative effect greater than that of an 'advanced organizer'." In fact, the results indicate that a post organizer actually hinders learning and retention. The results also fail to support the findings of Romberg and Wilson that the knowledge of the behavioral objective facilitates learning and retention nor do they support the significant interaction between the advanced organizer and the post organizer.

DISCUSSION

The experiment was conducted during forty-minute class periods. The extremely low score on the immediate learning test for the group that received all three treatments might indicate that these students felt rushed and did not feel free to study the lesson at a speed more condusive for their learning. This argument is somewhat refuted by the fact that the students who received AO and PO but not KBO did slightly better than the students who received either AO or PO but not both. It is difficult to believe that reading one additional sentence would result in almost a 20% decrease in test scores.

Ss in the studies of Bauman, Glass, and Harrington were undergraduate college students at the University of Colorado. In the study of Romberg and Wilson Ss were high school juniors from Grossmont, California, Madison, Wisconsin, and Wichita, Kansas. Ss in the present study were eighth grade students in Marshall, Illinois, a rural community in east central Illinois. It is possible that either the fact that the Ss in this study were younger

than those in the other studies or that they were located in a less urban environment than Ss in the other studies may partially explain the disparity of results.

Romberg and Wilson found a significant interaction between advanced organizers and post organizers. These results were certainly unexpected. This study does not support the findings of Romberg and Wilson and thus lends credence to the supposition that the findings of Romberg and Wilson were due to change.

Is there an important difference in the content of the organizers in these various studies? Perhaps a careful analysis of the content of the different organizers would provide some clue as the the reason behind these contradicotry results. More studies should be done in order to help ascertain why the results of the studies of Bauman, Glass, and Harrington, Romberg and Wilson, and the present study by Peterson are not consistent.

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Johnson, D. A. and Glenn, W. H. Topology--The Rubber-Sheet Geometry. St. Louis: Webster Publishing Company, 1960.

Romberg, T. A. and Wilson, J. W. "The effect of an advanced organizer, cognitive set, and summarization on the learning and retention of written materials." Paper presented to the Annual Meeting of the American Educational Research Association, Minneapolis, March, 1970.

TABLE 1

MEAN AND STANDARD DEVIATION FOR EFFECT OF ADVANCED ORGANIZER (AO), POST ORGANIZER (PO), AND KNOWLEDGE OF BEHAVIORAL OBJECTIVE (KBO) ON LEARNING

Group	$\bar{x}$	s.d.	Group	$\bar{x}$	s.d.
AO only	6.46	2.24	None	7.00	2.25
PO only	6.15	1.85	All AO	6.37	2.42
KBO only	6.92	2.74	No AO	6.73	2.34
AO x PO	6.54	2.55	All PO	6.23	2.29
AO x KBO	7.08	2.52	No PO	6.87	2.45
PO x KBO	6.85	2.34	All KBO	6.56	2.52
AO x PO x KBO	5.38	2.11	No KBO	6.54	2.24

TABLE 2

ANALYSIS OF VARIANCE FOR EFFECT OF ADVANCED ORGANIZER (AO), POST ORGANIZER (PO), AND KNOWLEDGE OF BEHAVIORAL OBJECTIVE (KBO) ON IMMEDIATE LEARNING

Source	SS	MS	df	F
AO	3.47	3.47	1	.59
KBO	.01	.01	1	.00
PO	10.47	10.47	1	1.77
AO x KBO	2.16	2.16	1	.37
PO x KBO	1.63	1.63	1	.28
AO x PO	.78	.78	1	.13
AO x KBO x PO	10.47	10.47	1	1.77
Error	566.77	5.90	96	
Total	595.76		103	

TABLE 3

MEAN AND STANDARD DEVIATION FOR EFFECT OF ADVANCED ORGANIZER (AO), POST ORGANIZER (PO), AND KNOWLEDGE OF BEHAVIORAL OBJECTIVE (KBO) ON RETENTION

Group	$\bar{x}$	s.d.	Group	$\bar{x}$	s.d.
AO only	7.77	2.55	None	7.23	2.67
PO only	6.23	1.63	All AO	7.29	2.21
KBO only	7.38	1.96	No AO	6.88	2.32
AO x PO	7.15	2.36	All PO	6.69	2.19
AO x KBO	7.54	1.82	No PO	7.48	2.28
PO x KBO	6.69	2.62	All KBO	7.08	2.12
AO x Po x KBO	6.69	1.90	No KBO	7.10	2.38

TABLE 4

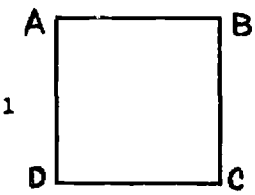
ANALYSIS OF VARIANCE FOR EFFECT OF ADVANCED ORGANIZER (AO), POST ORGANIZER (PO) AND KNOWLEDGE OF BEHAVIORAL OBJECTIVE (KBO) ON RETENTION

Source	SS	MS	df	F
AO	4.24	4.24	1	.80
KBO	.01	.01	1	.00
PO	16.16	16.16	1	3.04*
AO x PO	.09	.09	1	.02
AO x KBO	2.78	2.78	1	.52
PO x KBO	.01	.01	1	.00
AO x Po x KBO	.47	.47	1	.09
Within	510.46	5.32	96	
Total	534.22		103	

* < .10

Network 1 is a drawing of a square. The points where the line segments meet are called <u>vertices</u>. A, B, C, and D are all vertices.

Network 1



Two line segments meet at vertex A.

1. How many line segments meet at vertex C? _____

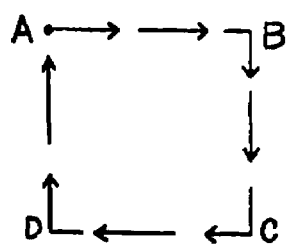
2. Is 2 an even or odd number? _____

Two line segments meet at vertex B. Since 2 is an even number, we shall say that vertex B is an even vertex.

3. Vertex D is an (even, odd) vertex. _____

4. Are all of the vertices of the square even? _____

We can draw this square without lifting the pencil from the paper and without crossing any lines by starting at vertex A and following the path indicated below.

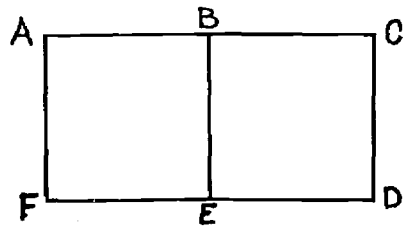


Checkpoint 1

1. 2 2. even 3. even 4. even

Below is the drawing of Network 2.

Network 2



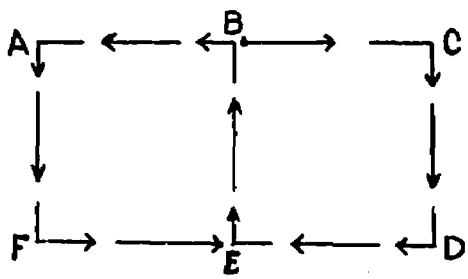
5. This network has six vertices. These six vertices are lettered A, B, C, D, _____, and _____.

6. Vertex A is an even vertex because _____ line segments meet at vertex A.

7. Is vertex B an even or an odd vertex? _____

8. All together there are _____ even vertices and _____ odd vertices.

You can trace Network 2 without lifting your pencil from the paper and without crossing any lines by starting at vertex B and following the path indicated below.

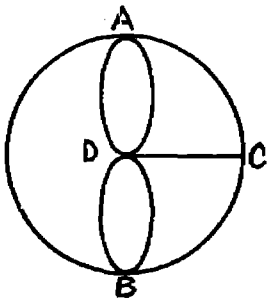


Checkpoint 2

5. E, F 6. 2 7. odd 8. 4, 2

Below is Network 3.

Network 3

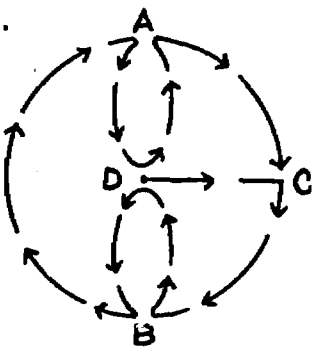


9. The even vertices are B and _____.

10. The odd vertices are C and _____.

11. All together there are _____ even and _____ odd vertices.

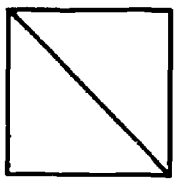
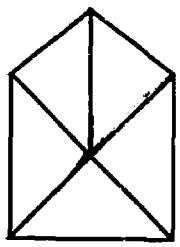
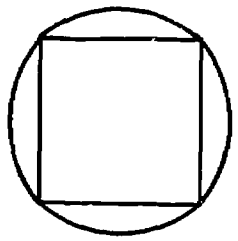
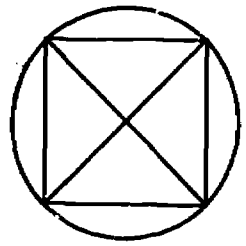
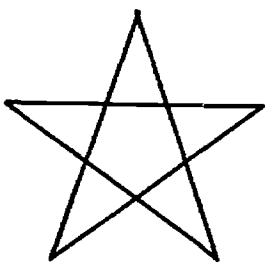
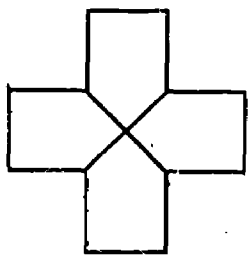
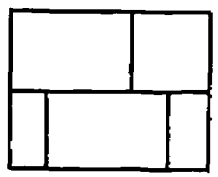
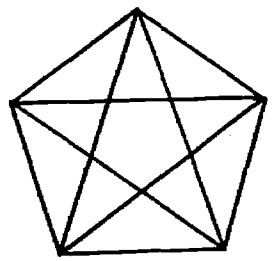
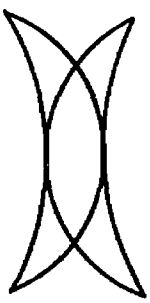
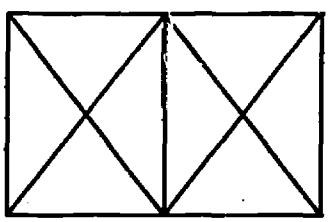
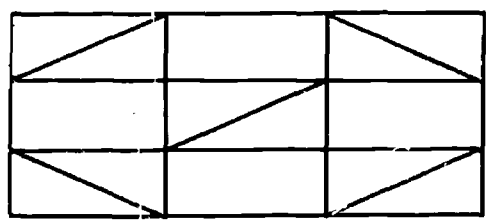
You can trace Network 3 without lifting your pencil from the paper and without crossing any lines by starting at vertex D and following the path indicated below.



Checkpoint 3

9. A 10. D 11. 2, 2

For each of the Networks 4 through 14, count the number of even vertices and the number of odd vertices. Complete the table that follows the networks.

Network	Even Vertices	Odd Vertices	Can it be traced?
1	4	0	Yes
2	4	2	Yes
3	2	2	Yes
4			Yes
5			No
6			Yes
7			No

Network	Even Vertices	Odd Vertices	Can it be traced?
8			Yes
9			No
10			No
11			Yes
12			Yes
13			No
14			Yes

Your answers should be the same as those in the table below.

Network	Even Vertices	Odd Vertices	Can it be traced?
1	4	0	Yes
2	4	2	Yes
3	2	2	Yes
4	2	2	Yes
5	0	6	No
6	4	0	Yes
7	1	4	No

Network	Even Vertices	Odd Vertices	Can it be traced?
8	10	0	Yes
9	9	4	No
10	4	8	No
11	10	0	Yes
12	8	0	Yes
13	2	6	No
14	14	2	Yes

12. Can a Network be traced if it has only 2 odd vertices?

13. Can a Network be traced if it has more than 2 odd vertices?

14. Can a Network be traced if it has all odd vertices?

15. Can a Network be traced if it has only 2 even vertices?

16. Can a Network be traced if it has more than 2 even vertices?

17. Can a Network be traced if it has all even vertices?

Checkpoint 4

12. Yes 13. No 14. No 15. No 16. No 17. Yes

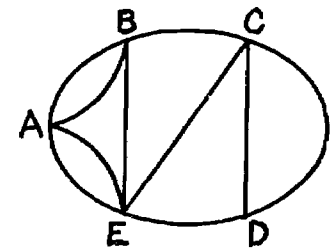
Your answers to these questions will help you see a relationship. If a network has all even vertices or only 2 odd vertices then it can be traced without lifting the pencil from the paper and without crossing any lines.

Test I

Name _____ Teacher _____

Circle the letter to the left of the correct response.

Use Network 1 to answer questions 1 - 4.



Network 1

1. _____ line segments meet at vertex D.

   a) 2 b) 3 c) 4 d) 5

2. _____ line segments meet at vertex E.

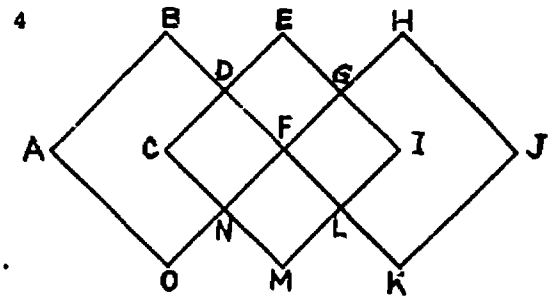
   a) 2 b) 3 c) 4 d) 5

3. Vertex B is a(n) _____ vertex.

   a) even b) odd c) double d) triple

4. There are _____ even vertices in Network 1.

   a) 1 b) 2 c) 3 d) 4



Network 2

Use Network 2 to answer questions 5 - 8.

5. _____ line segments meet at vertex C.

   a) 2 b) 3 c) 4 d) 5

6. _____ line segments meet at vertex N.

   a) 2 b) 3 c) 4 d) 5

7. Vertex F is a(n) _____ vertex.

   a) even b) odd c) double d) triple

8. There are _____ even vertices in Network 2.

   a) 0 b) 2 c) 14 d) 15

9. If a network can be traced then it must have

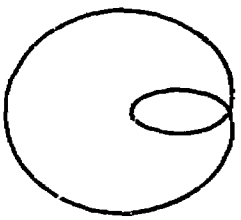
   a) exactly two odd vertices
   b) more than two odd vertices
   c) zero or two odd vertices
   d) exactly zero odd vertices

10. If a network has 4 even vertices and 2 odd vertices then

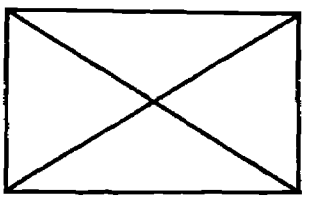
   a) it can be traced
   b) it cannot be traced
   c) perhaps it can be traced
   d) perhaps it cannot be traced

11. Below are two networks.

Network 3



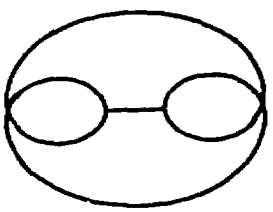
Network 4



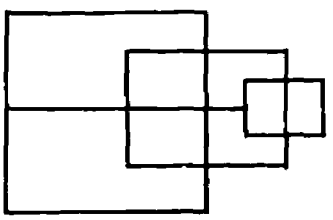
   a) Only Network 3 can be traced
   b) Only Network 4 can be traced
   c) Both Network 3 and Network 4 can be traced
   d) Neither Network 3 nor Network 4 can be traced.

12. Below are Networks 5 and 6.

Network 5



Network 6



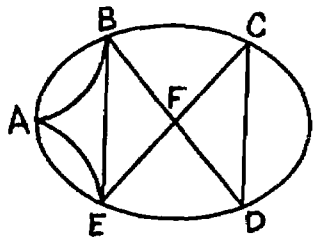
   a) Only Network 5 can be traced.
   b) Only Network 6 can be traced.
   c) Both Network 5 and Network 6 can be traced.
   d) Neither Network 5 nor Network 6 can be traced.

Test II

Name _____ Teacher _____

Circle the letter to the left of the correct response.

Use Network 1 to answer questions 1 - 4.



Network 1

1. _____ line segments meet at vertex D.

   a) 2 b) 3 c) 4 d) 5

2. _____ line segments meet at vertex E.

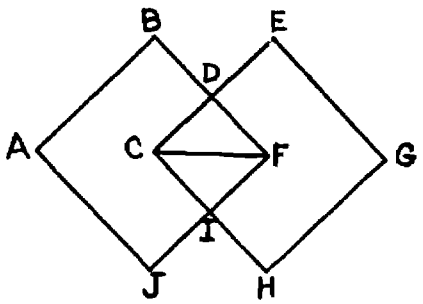
   a) 2 b) 3 c) 4 d) 5

3. Vertex B is a(n) _____ vertex.

   a) even b) odd c) double d) triple

4. There are _____ even vertices in Network 1.

   a) 1 b) 2 c) 3 d) 4



Network 2

Use Network 2 to answer questions 5 - 8.

5. _____ line segments meet at vertex C.

   a) 2 b) 3 c) 4 d) 5

6. _____ line segments meet at vertex J.

   a) 2 b) 3 c) 4 d) 5

7. Vertex F is a(n) _____ vertex.

   a) even b) odd c) double d) triple

8. There are _____ even vertices in Network 2

   a) 0 b) 2 c) 8 d) 10

9. If a network can be traced then it must have

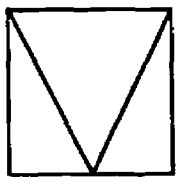
   a) exactly zero odd vertices
   b) zero or two odd vertices
   c) more than two odd vertices
   d) exactly two odd vertices

10. If a network has 2 even vertices and 4 odd vertices then

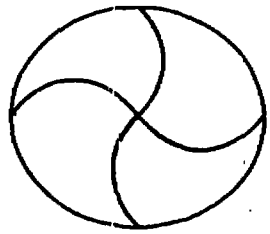
   a) it can be traced.
   b) it cannot be traced.
   c) perhaps it can be traced.
   d) perhaps it cannot be traced.

11. Below are Networks 3 and 4.

Network 3



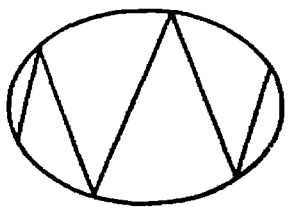
Network 4



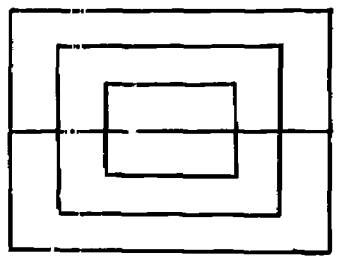
   a) Only Network 3 can be traced.
   b) Only Network 4 can be traced.
   c) Both Network 3 and Network 4 can be traced.
   d) Neither Network 3 nor Network 4 can be traced.

12. Below are Networks 5 and 6.

Network 5



Network 6



   a) Only Network 5 can be traced.
   b) Only Network 6 can be traced.
   c) Both Network 5 and Network 6 can be traced.
   d) Neither Network 5 nor Network 6 can be traced.